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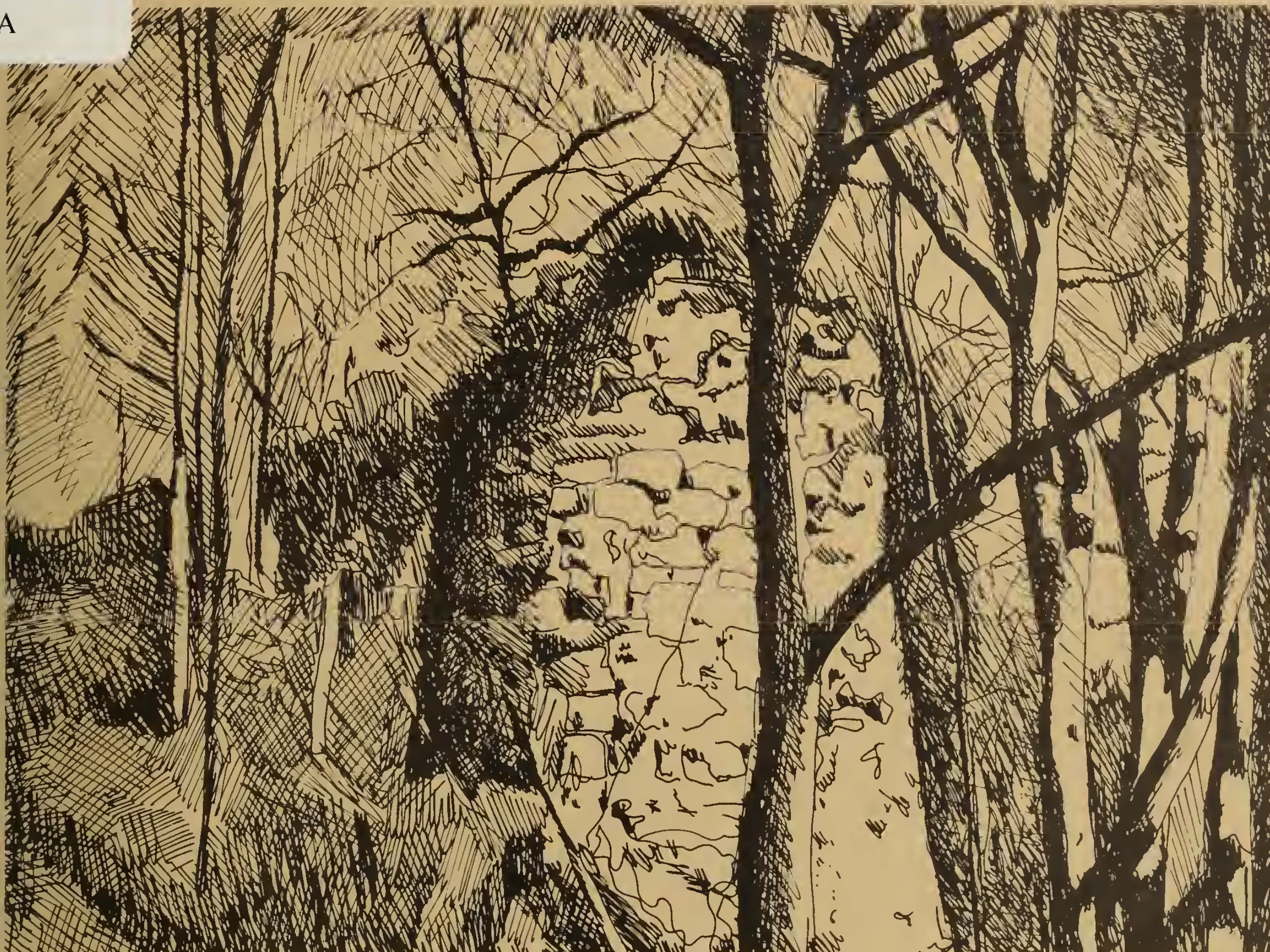
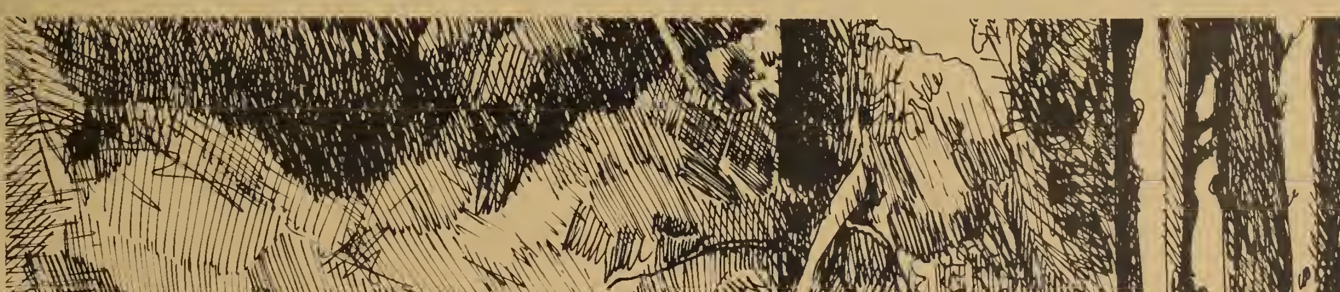


Field Trip Guide Leaflet 1981 A
April 25, 1981
Illinois Institute of Natural Resources
State Geological Survey Division
Champaign, Il 61820

A guide to the geology of the Cairo area

David L. Reinertsen John M. Masters Philip C. Reed



COVER: Sketch of photograph of first lime kiln constructed northwest of Ullin in early 1880s. *(By Craig Ronto, ISGS.)*

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A guide to the geology of the Cairo area

David L. Reinertsen John M. Masters Philip C. Reed

GEOLOGICAL SCIENCE FIELD TRIPS are free tours conducted by the Educational Extension Section of the Illinois State Geological Survey to acquaint the public with the geology and mineral resources of Illinois. Each is an all-day excursion through one or several counties in Illinois; frequent stops are made for explorations, explanations, and collection of rocks and fossils. People of all ages and interests are welcome. The trips are especially helpful to teachers in preparing earth science units. Grade school students are welcome, but each must be accompanied by a parent. High school science classes should be supervised by at least one adult for each ten students. A list of previous field trip guide leaflets is available for planning class tours and private outings.

The Cairo area is located in extreme southern Illinois at the confluence of the Mississippi and Ohio Rivers. This is one of two regions in Illinois where Paleozoic, Mesozoic, and Cenozoic strata occur together. The field trip area lies within parts of three physiographic provinces—the Interior Low Plateaus Province, the Ozark Plateaus Province, and the Coastal Plain Province (see attached Physiographic Divisions of Illinois map). Most of the itinerary is within the northern part of the Coastal Plain Province, a region of low, gentle hills formed upon soft Mesozoic and Cenozoic sediments. The itinerary skirts the southeastern part of the Ozark Plateaus Province, a region of rugged hills and high surface elevations, underlain here by deeply weathered Paleozoic chert and cherty limestone formations. The last stop is along the southwestern edge of the Interior Low Plateaus Province, a region of rugged, scenic terrain developed on resistant Paleozoic strata.

the geologic framework

The boundary between two major geologic structures—the Illinois Basin to the north and the Mississippi Embayment to the south—occurs along the northern part of the field trip area (fig. 1). The Illinois Basin is a large bedrock structure containing a thick sequence of Paleozoic sedimentary rocks that have been warped into a great spoon-shaped depression, 250 to 300 miles in diameter, that covers most of Illinois and adjacent parts of Indiana and Kentucky (figs. 1 and 2 and attached Geologic Map of Illinois). The deepest part of the basin in Illinois is in northeastern Pope County, about 55 miles northeast of the Cairo area. In that part of the basin, deep oil-test wells indicate that Paleozoic strata probably exceed 17,000 feet.

These strata were deposited in the ancient shallow seas that periodically covered Illinois and the Midwest during the Paleozoic Era from Cambrian time, about 570 million years ago, until at least the close of the Pennsylvanian Period, about 280 million years ago. It seems likely that an undetermined thickness of younger Pennsylvanian, and perhaps even strata of the Permian System (the youngest Paleozoic rocks) were deposited across this region and then subsequently removed by erosion over millions of years. The base of the Cambrian sedimentary rocks rests upon an ancient Precambrian basement of crystalline granitic rocks more than one billion years old (figs. 2 and 3).

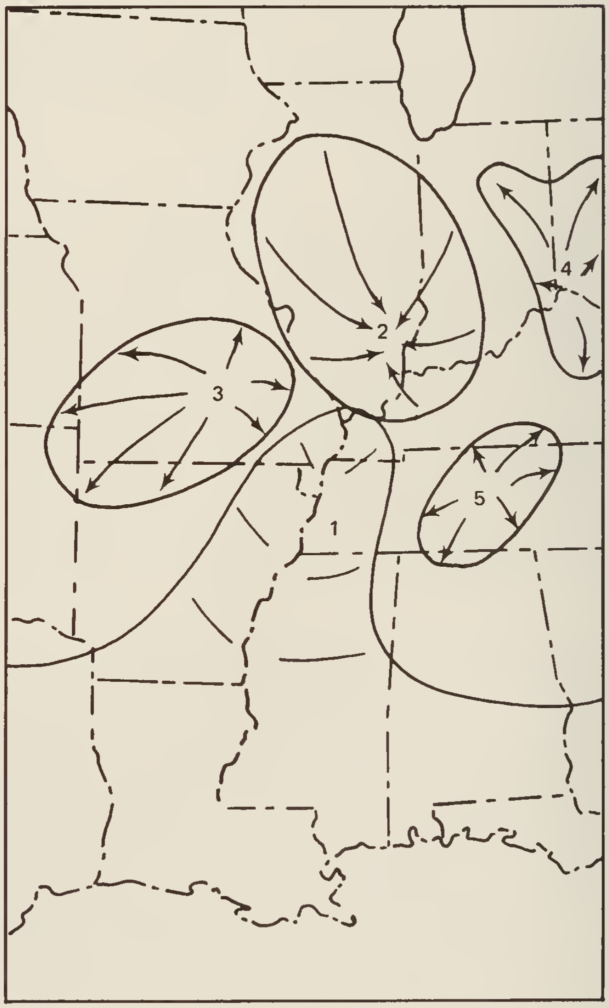


Figure 1. Index map showing the location of the Mississippi Embayment and adjacent major structures: (1) Mississippi Embayment, (2) Illinois Basin, (3) Ozark Dome, (4) Cincinnati Arch, and (5) Nashville Dome.

The Cairo field trip area is situated near the extreme southern margin of the Illinois Basin where it is underlain by about 12,500 feet of Paleozoic rocks ranging in age from Cambrian up to middle Mississippian. Only Paleozoic rocks of Devonian and middle Mississippian age are exposed in this field trip area (fig. 3). Devonian rocks consist largely of chert and cherty limestone formations and some sandstone. The middle Mississippian (Valmeyeran) consists predominantly

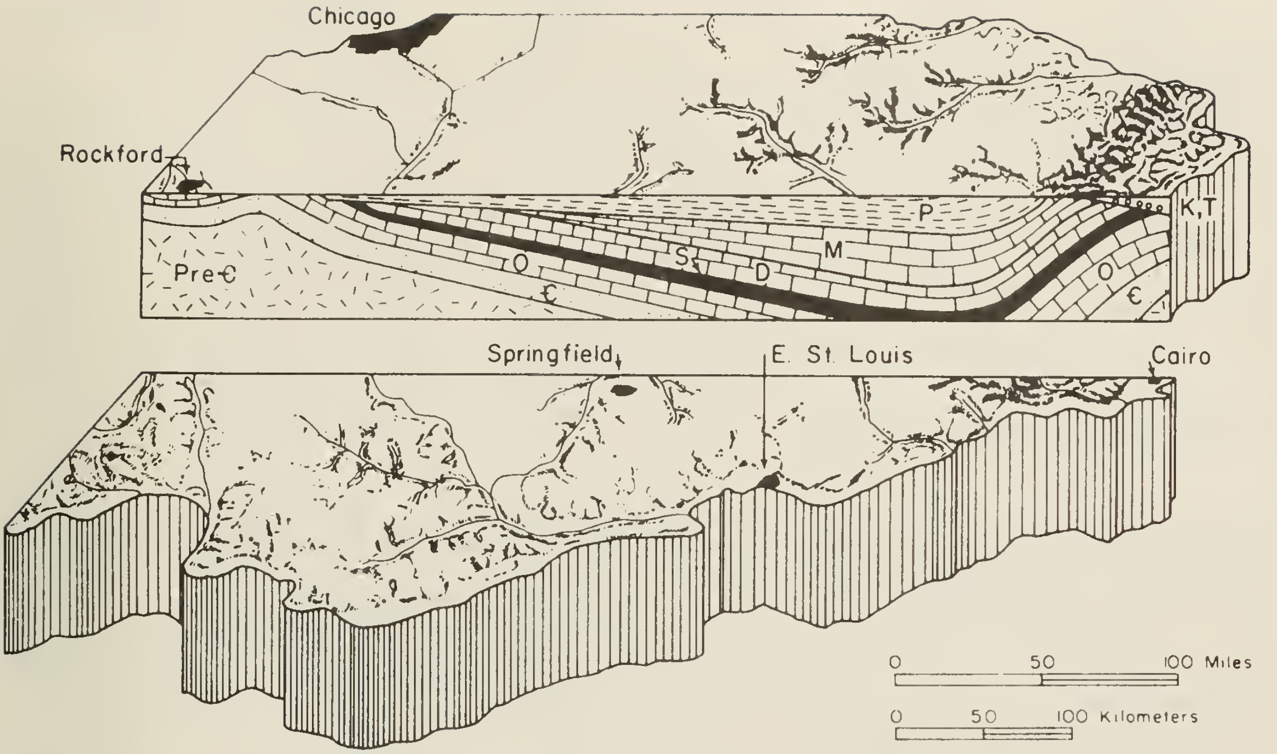


Figure 2. Stylized north-south cross section shows the structure of the Illinois Basin. In order to show detail, the thickness of the sedimentary rocks has been greatly exaggerated and the younger, unconsolidated surface deposits have been eliminated. The oldest rocks are Precambrian (Pre-C) granites. They form a depression that is filled with layers of sedimentary rocks of various ages: Cambrian (C), Ordovician (O), Silurian (S), Devonian (D), Mississippian (M), Pennsylvanian (P), Cretaceous (K), and Tertiary (T). The scale is approximate.

of limestone although some siltstone and sandstone are present. (See attached Mississippian Deposition). These Mississippian strata were deposited about 330 million years ago in shallow seas that covered the mid-continent region. Hundreds of feet of younger Mississippian and Pennsylvanian strata, which occur a few miles to the north and east, also once covered the Cairo area, but erosion stripped them away during the 190 million years or so that followed the withdrawal of the Pennsylvanian seas and preceded the advance of the upper Cretaceous sea.

STRUCTURE OF THE PALEOZOIC ROCKS

Regionally the Paleozoic strata are tilted downward about 2 degrees to the north and east into the Illinois Basin (fig. 2). The Cairo area is located close to that portion of southern Illinois where faulting of Paleozoic strata has been extensive and, as a consequence, stratigraphic relationships of the various rock units are complicated. In the field trip area, however, only a few, short, northward trending faults with only a few feet of vertical displacement are known. Available data indicate that these faults developed sometime after the close of the Pennsylvanian Period nearly 280 million years ago.

ERA	SYSTEM	SERIES	GROUP	FORMATION	GRAPHIC COLUMN	THICKNESS (ft)
CENOZOIC	QUATERNARY	PLEISTOCENE		Loess, alluvium, and colluvium		0-250
	TERTIARY-QUATERNARY	PLIOCENE-PLEISTOCENE		Mounds Gravel		0-50
	TERTIARY	EOCENE		Wilcox		0-250
		PALEOCENE		Porters Creek		0-150
				Clayton		0-20
MESOZOIC	CRETACEOUS	GULFIAN		Owl Creek		0-10
				Levings Member McNairy		25-455
				Tuscaloosa		0-170
PALEOZOIC	MISSISSIPPIAN	CHESTERIAN		Little Bear Soil*		0-10
				(formations not differentiated in this report)		1000
		VALMEYERAN		Ste. Genevieve		200-240
				St. Louis		350
				Salem		250-425
				Ullin		150-580
				Fort Payne		0-670
				Springville		5-50
		KINDERHOOKIAN		Chouteau		0-4
	DEVONIAN	UPPER	New Albany Shale			100-300
		MIDDLE		Alto-Lingle		0-50
				Grand Tower		0-80
		LOWER		Clear Creek		1200
				Backbone		
				Grassy Knob		
				Bailey		
	SILURIAN	? CAYUGAN ?		Moccasin Springs		200
		NIAGARAN		St. Clair		
		ALEXANDRIAN		Sexton Creek		5-90
				Edgewood		
	ORDOVICIAN	CINCINNATIAN		Girardeau		0-30
			Maquoketa Shale	Scales Thebes Ss. Mbr.		100-300
		CHAMPLAINIAN		Cape		0-8
			Galena			100-150
			Platteville			550-650
			Ancell	Joachim		385
				Dutchtown		200
				St. Peter		100-150
				Everton		90-500
		CANADIAN	Prairie du Chien	Shakopee		3100-3300

*Soil developed on Paleozoic rocks that range in age from Ordovician to Mississippian.

ISGS 1980

Figure 3. Generalized stratigraphic column of southernmost Illinois (Cambrian section not shown). (From Kolata, 1981.)

THE MISSISSIPPI EMBAYMENT

The Mississippi Embayment, floored by Paleozoic strata, is a broad, gentle syncline, or trough, that deepens southward toward the Gulf of Mexico; the northern part of the axis of the syncline trends northeastward paralleling the major structural trend in extreme southern Illinois. This trough, also called the Embayment Syncline, is bordered on the west by the Ozark Dome, on the east by another large bedrock arch in western Tennessee known as the Nashville Dome, and on the north by the southern margin of the Illinois Basin (fig. 1). The Embayment Syncline was formed by movements of the Earth's crust, which began during late Cretaceous time, about 90 million years ago, and continued until the end of the Eocene Epoch in Tertiary time, about 38 million years ago. As the trough subsided, an arm of the sea advanced northward into the Embayment from the present site of the Gulf of Mexico, inundating the southern tip of Illinois at least twice during Cretaceous time and twice during Tertiary time. The Tertiary inundation during the Eocene Epoch marked the last time that the sea reached into Illinois. The Cretaceous and Tertiary strata deposited during these invasions fill the Embayment Syncline and form a wedge-shaped body of unconsolidated marine and nonmarine clays, silts, sands, and gravels. Gradually the wedge thickens southward from a thin erosional edge in extreme southern Illinois to more than 3,000 feet near Memphis, Tennessee. In the Cairo area a maximum thickness of about 600 feet of these relatively young sedimentary strata overlaps, and rests unconformably upon, the much older Paleozoic sedimentary rocks (figs. 2 and 3).

After the sea withdrew at the end of Eocene time, the region was uplifted, and erosion has continued to the present. At some time during the Pliocene Epoch, which lasted from about 12 million years ago up to some 2 to 3 million years ago, a great river system flowed across the region. Streams from this system deposited an extensive sheet of sand and coarse gravel over a large area of the Ohio River region. These materials, called the Mounds ("Lafayette") Gravel, thinly mantle the Paleozoic, Mesozoic, and earlier Cenozoic strata and cap most of the hills in the Cairo area (fig. 3).

PLEISTOCENE HISTORY

The extensive continental glaciers that covered northern North America and large portions of Illinois and the Midwest during the Pleistocene Epoch, commonly referred to as "The Great Ice Age," did not extend as far south as the Metropolis area. (See attached blue Pleistocene maps and time scale.) The Illinoian glacier, the third of four major glacial advances, was the most extensive in the state and advanced to an irregular margin extending westward from north of Harrisburg (Saline County) to south of Carbondale (Jackson County). The southernmost point of continental glaciation is about 1.5 miles south of the north boundary of Johnson County, nearly 40 miles north-northeast of Cairo. Although till deposited directly by the glaciers is not found here, other materials called *outwash*, composed of silt, sand, and gravel, were deposited by sediment-laden meltwater streams pouring away from the ice fronts during both advance and waning of the glaciers. Major river valleys, such as the Mississippi and Ohio

Valleys, were the main channels for the escaping meltwaters, and thus these valleys were greatly deepened and widened during times of greatest flood. During times of decreased meltwater flow, however, the valleys became filled and choked with outwash called *valley trains* far beyond the ice margins. Near Cairo, outwash deposits in the Mississippi River are as much as 250 feet thick. About 13,000 years ago, near the end of the last glacial stage (the Wisconsinan) in Illinois, a great flood of meltwater poured down these valleys and caused major changes in the channels of the Mississippi and Ohio Rivers. The changes affecting the Ohio River will be discussed in detail at later stops along the itinerary.

Deposits of wind-blown silt, called *loess* (pronounced "luss"), are also the result of glaciation in Illinois; they blanket the uplands of the Cairo area. The silt was blown from the floodplain of the Mississippi River and from the floodplain of the Ohio River when it occupied the Cache River-Bay Creek Valley. Although thicknesses as great as 50 feet are known along the Mississippi Valley, the loess thins eastward to a maximum of about 15 feet in the field trip area. The loess is generally less than 3 feet thick on the lower terrace. Loess deposits of Illinoian and Wisconsinan ages are present.

ECONOMIC GEOLOGY

The Survey's annual report of mineral production in Illinois in 1978, the last date for which complete statistics are currently available, summarized the output and value of minerals produced, minerals processed in Illinois, and mineral products manufactured but not necessarily mined in Illinois, which all totaled about $3,170,700,000. The total value of minerals mined was about $1,637,000,000; the mineral fuels—coal, crude oil, and natural gas—constitute nearly 81 percent of the total. Industrial and construction materials, which include crushed and broken stone, sand and gravel, absorbent clay, and prepared tripoli, were valued at $304,026,000 in 1978.

One company produced sand and gravel, and two companies produced tripoli in Alexander County, which ranked 54th among the 99 mineral-producing counties during 1978. Actual production figures have been withheld to avoid disclosing individual company data.

In Pulaski County, one company produced gravel, another produced stone, and two companies produced absorbent clay. The county ranked 43rd among the 99 mineral-producing counties during 1978. Actual production figures have also been withheld for Pulaski County to avoid disclosing individual company data.

guide to the route

The field trip begins south of Cairo at the Riverboat Memorial in Fort Defiance State Park, which was dedicated in 1960. This area is also known as "Cairo Point," and is the southernmost part of Illinois. The actual southernmost tip of our state is on an island, Angelo Towhead, about 1.75 miles west and a little more than 0.5 miles south from the Riverboat Memorial. Riverboat Memorial (SE 1/4 SE 1/4 SE 1/4 Sec. 31, T. 17 S., R. 1 E., 3rd P.M., Alexander County. Wyatt 7.5-minute Quadrangle).

According to the brochure on Ft. Defiance State Park, printed by the Illinois Department of Conservation, French explorers recognized the importance of this point of land both for settlement and for fortification, as early as 1673. In 1778, George Rogers Clark stationed armed boats here to guard against attack by the British or Spanish. In 1848, a cannon was installed at the confluence of the rivers to greet arriving riverboats. During the Civil War this cannon was aimed down the river to thwart any attacks from the South.

This locality affords an excellent opportunity to view the confluence of the Mississippi and Ohio Rivers and to see some of the barge traffic that moves on this important waterway. The Mississippi River System includes all main channels and all tributaries of the Mississippi, Illinois, Missouri, and Ohio Rivers. The Mississippi River itself is open to river commerce for more than 1,830 miles—from Minneapolis, Minnesota, to the mouth of the river at Southwest Pass, Louisiana. During 1977, more than 536,826,836 short tons of more than 100 different commodities were transported on the Mississippi River System. Commodities of more than 5,000,000 tons carried on the river that year included the following:

Commodity	Tons	Commodity	Tons
Corn	23,019,123	Grain mill products	5,470,363
Wheat	6,719,684	Basic chemicals and products	10,072,166
Soybeans	11,033,696	Gasoline	20,318,985
Coal and lignite	117,570,119	Distillate fuel oil	13,198,380
Sand, gravel, crushed rock	33,003,931	Residual fuel oil	23,439,195
Crude petroleum	18,843,431	Waterway improvement materials	6,889,885

Commodities for export include corn, wheat, soybeans, coal and lignite, grain mill products, and basic chemicals and products. Imports include aluminum ore concentrates, crude petroleum, sugar, iron and steel plates and sheets. More than 64,000 towboat, tugboat, and other self-propelled cargo and passenger trips in conjunction with more than 132,500 barge and tanker trips were needed each way to move these commodities. In addition, more than 2,248,000 passengers, exclusive of ferry passengers, traveled on the Mississippi River System in 1977.

River traffic has been steadily increasing for years, and it seems likely that it will continue to increase because of the need for cheap, efficient transportation to carry the raw materials and finished products needed by our own country as well as by foreign countries. This will, inevitably, cause a variety of problems. Industries are locating close to the river because of the easy access to cheap transportation; this will cause an increase in the amount of river traffic. Not only will more traffic accelerate riverbank erosion, but it will also bring more pressure for larger locks and dams. Larger dams and higher water levels will necessitate the flooding of larger floodplain tracts and thus reduce the amount of prime farm land along the rivers.

This locality also affords the opportunity of examining the system of land surveys in Illinois. An examination of the 15- and 7.5-minute quadrangles of this tip of Illinois shows that section lines do not show an even grid pattern over the whole area. In some areas section lines have been omitted; in other areas there are some lines that are quite irregular and represent old French land grants, established when early French settlers were mainly concerned about the amount of riverfront footage that they could buy. Additionally, the 3rd Principal Meridian does not appear on these maps, even though a decision in 1805 regarding land surveys designated the mouth of the Ohio as the beginning point for this meridian. To obtain the description used in this guide leaflet for the Riverboat Memorial, the meridian was extended southward from the Mound City area.

In 1804, initial surveying from the 2nd P.M. (fig. 4) continued westward from Vincennes, Indiana; this survey became the basis for surveying about 10 percent of what is now eastern Illinois. Because the western boundary of this tract had not been established with certainty, it was decided in 1805 to designate the 3rd P.M. as beginning at the mouth of the Ohio River and extending northward to facilitate surveying new land cessions. By late 1805 a base line had been run due east to the Wabash River and due west to the Mississippi River from the 3rd P.M. During March 1806, surveying commenced northward on both sides of the 3rd P.M. Sometime after the selection of an initial point from which to establish a base line, and from which the surveys were to be laid out, the base line apparently was arbitrarily moved northward 36 miles, where it roughly coincides with the base line of the 2nd P.M.

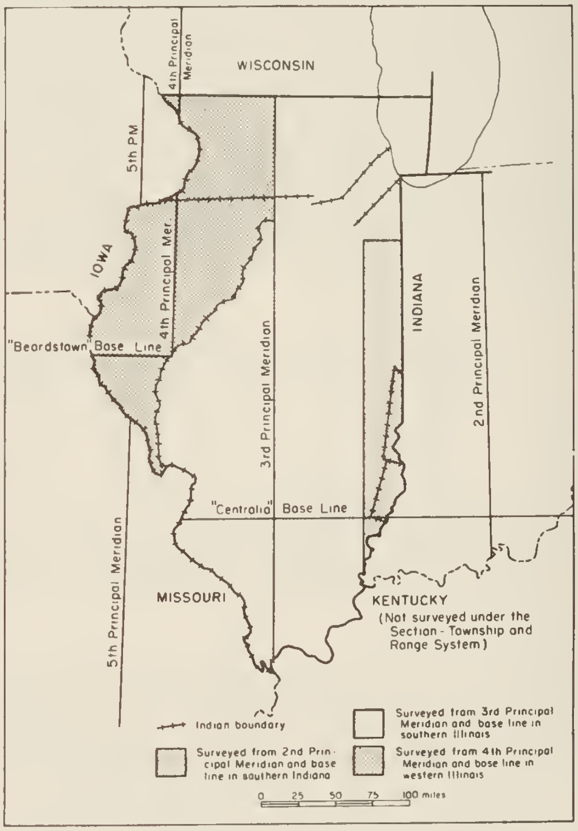


Figure 4. Principal meridians and base lines of Illinois and surrounding states. (From Cote, 1978.)

The township and range system permits the accurate identification of

most parcels of land in Illinois to facilitate the sale and transfer of public and private lands. In the early 1800s, each normal township was divided (to the best of the surveyor's ability) into 36 sections, each of which was 1 mile square and contained 640 acres (see route map).

Township and range lines in figure 5 do not form a perfect rectangular grid over the state because of the use of different base lines and principal meridians and because minor offsets were necessary to compensate for the Earth's curvature. The surveying corrections producing the minor offsets were usually made at regular intervals of about 30 miles. Figure 5 shows what happened when the survey from the 2nd P. M. met the survey from the 3rd P.M. From Iroquois County south to White County, only narrow partial townships could be made where the two surveys met. These partial townships are all located in R. 11 E. and, in most places, are less than one section wide.

Miles to next point	Miles from starting point

0.0 0.0
Leave Riverboat Memorial and head northward out of park.

0.6 0.6
CAUTION—ascend hill and cross Illinois State Police parking area.

0.05 0.65
STOP—TURN RIGHT (northwesterly) on U.S. 60.

0.1 0.75
CAUTION—STOPLIGHT. CONTINUE AHEAD (northwesterly) on U.S. 51 toward Cairo.

0.75 1.5
CAUTION—descend levee on Washington Street in Cairo.

0.45 1.95
CAUTION—STOPLIGHT; 8th Street. CONTINUE AHEAD (northwest) on Washington Street.

0.25 2.2
Cairo City Building to upper right. Constructed in 1870, it was the U.S. Custom House for Port of Delivery.

0.35 2.55
CAUTION—DANGEROUS INTERSECTION. BEAR RIGHT (north-northwest) on Sycamore Street and U. S. 51.

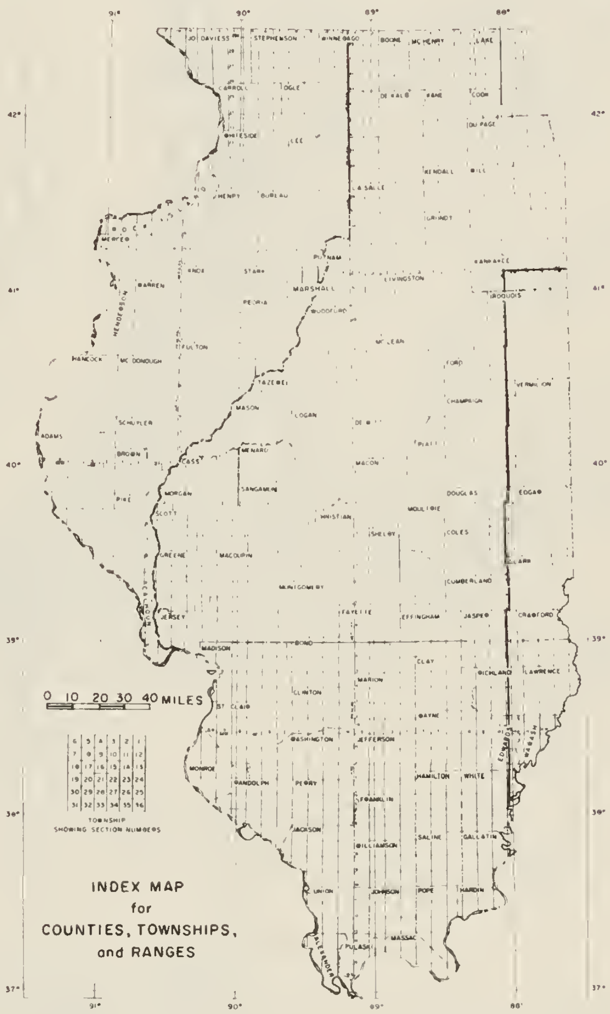
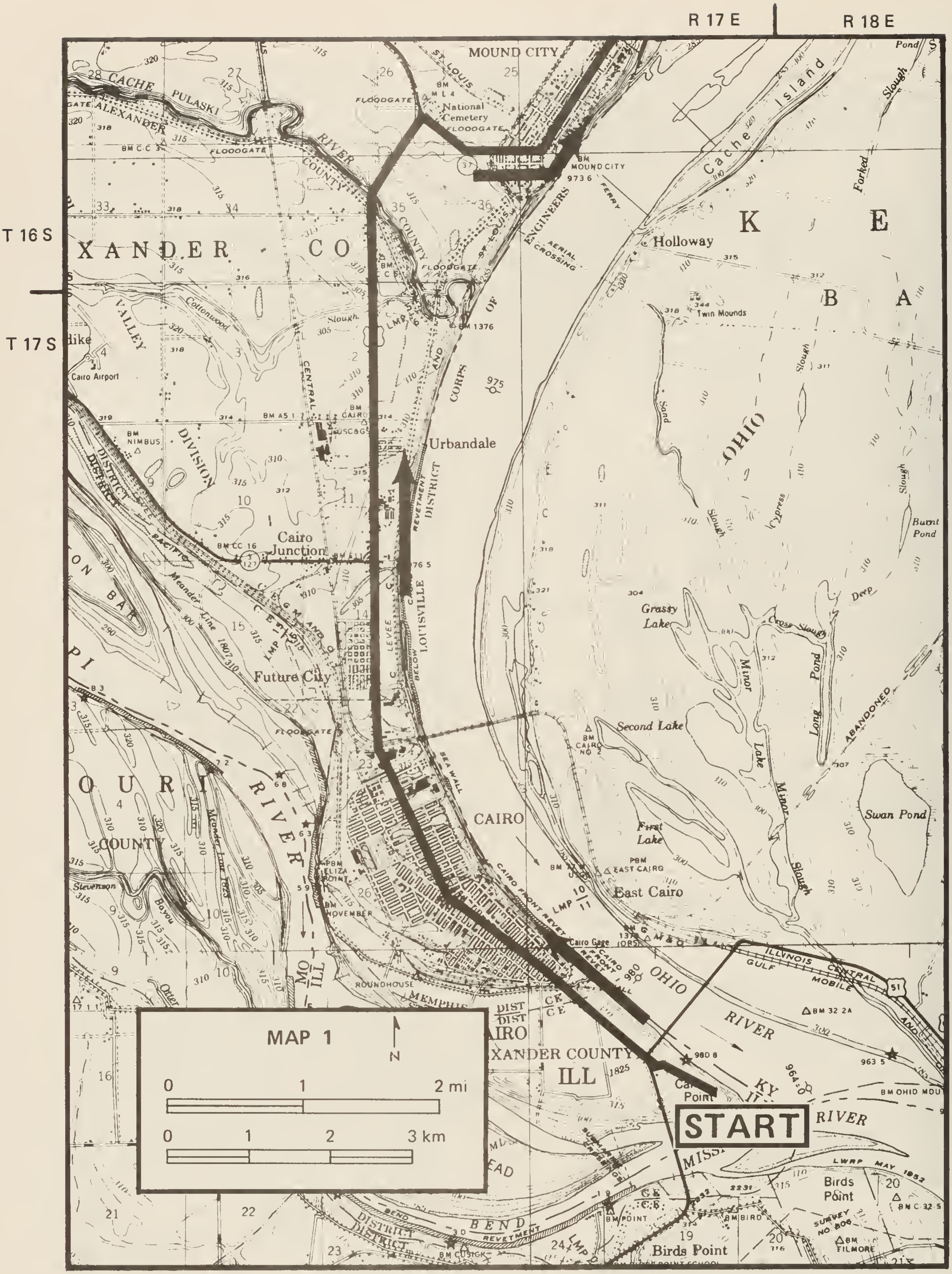


Figure 5. Index map. (From Cote, 1978.)



R 17 E
R 18 E
T 16 S
T 17 S
MAP 1
N
0 1 2 mi
0 1 2 3 km
START
MOUND CITY
National Cemetery
Holloway
Twin Mounds
Cairo Airport
Urbandale
Cairo Junction
Future City
CAIRO
East Cairo
Cairo Point
Birds Point
Cache Island
Grassy Lake
Second Lake
First Lake
Swan Pond
Burnt Pond
Long Pond
Minor Lake
OHIO RIVER
MISSISSIPPI RIVER
ALEXANDER COUNTY ILL
ROUNDHOUSE
SEAWALL
ABANDONED

Miles to next point	Miles from starting point	
		NOTE: The modern one-story office building to the upper left on the west corner of 20th and Washington Streets is the corporate office of the Illinois Minerals Company, incorporated in 1916. This company is the largest producer of amorphous silica (tripoli) in the United States. Its processing plant is located in Elco near the northern edge of the field trip area.
0.4	2.95	CAUTION—STOPLIGHT, 28th Street. CONTINUE AHEAD.
0.65	3.6	CAUTION—Conrail crossing.
0.1	3.7	CAUTION—Conrail crossing.
0.05	3.75	Illinois Central Gulf Railroad (ICG RR) overpass and the Cairo levee north floodgate.
1.2	4.95	CAUTION—STOPLIGHT. TURN RIGHT (east and then north) on U.S. 51 towards Mounds.
1.1	6.05	J. D. Street Marine Oil Terminal to right.
0.4	6.45	Cairo Historical Marker to right in rest area.
1.3	7.75	Cross old channel of Cache River and enter Pulaski County.
0.6	8.35	BEAR RIGHT (southeast) at Y-intersection on Ill. 37 toward Mound City. Mound City National Cemetery is across the intersection (northeast side).
0.65	9.0	CAUTION—enter Mound City.
0.15	9.15	Marine Ways Historical Marker to left.

> DURING THE CIVIL WAR THE NAVAL DEPOT OF THE WESTERN RIVER FLEET WAS LOCATED AT MOUND CITY. HERE THE KEELS OF THREE OF THE FAMOUS EADS IRONCLAD GUNBOATS WERE LAID, AND A LARGE FORCE OF WORKMEN WERE EMPLOYED TO KEEP THE FLEET IN FIGHTING TRIM. THE MARINE WAYS, STILL IN OPERATION, ARE 400 YARDS SOUTH OF HERE.
> *(Dated 1935) (No longer operating)*

0.15	9.3	BEAR LEFT (northeast) on Ill. 37 through the business district.
0.95	10.25	Ascend levee and leave Mound City.
1.7	11.95	A good view of the Cache River bottoms to the left.
0.7	12.65	CAUTION—Mounds Road to left. CONTINUE AHEAD (northeast).
1.0	13.65	The slightly rolling land surface here represents

		a terrace level having a surface elevation of about 340 feet mean sea level (m.s.l.).
3.8	17.45	Prepare to turn right.
0.15	17.6	TURN RIGHT (east) on Olmsted Road.
0.1	17.7	CAUTION—enter Olmsted.
0.15	17.85	BEAR RIGHT (southeast) on Cedar Street at Post Office and ascend hill.
0.45	18.3	TURN RIGHT (east) on Mill Street at Lowe's Southern Clay Company sign.
0.2	18.5	CAUTION—plant area. TURN LEFT (east) into parking lot at Lowe's Southern Clay Company office.

STOP 1

Lowe's Southern Clay Company. NE 1/4 SW 1/4 NW 1/4 NW 1/4 Sec. 26, T. 15 S., R. 1 E., 3rd P.M., Pulaski County; Olmsted 7.5-minute Quadrangle.

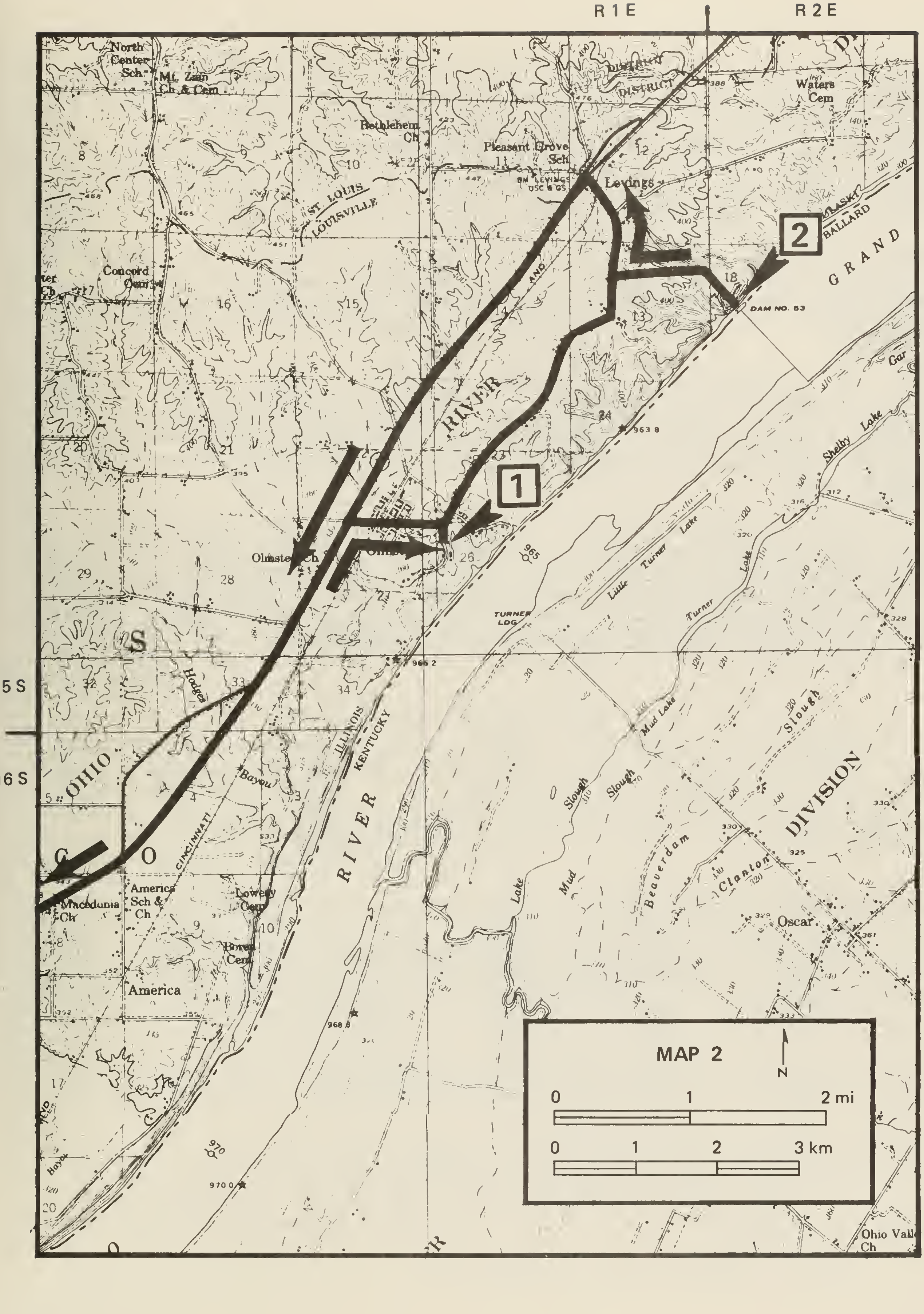
Clay mined here is a special type that absorbs oils and greases. In Europe, the term "fuller's earth" was originally applied to clay used for fulling wool, that is, removing the natural oils and greases from sheep's wool. Later this clay was discovered to have the ability to remove basic colors from oils. Petroleum companies then used it for decolorizing various oils and eventually began mining the clay.

In 1920, Sinclair Refining Company mined fuller's earth at this locality, the first production of this clay in Illinois. Shortly thereafter, Standard Oil Company of Indiana opened a mine and processing plant about half a mile southwest of here. For many years this clay was used principally for clarifying and filtering animal, vegetable, and mineral oils, fats, and greases, and in the manufacture of wallpaper pigments, talcum powder substitute, and for medicinal purposes.

In 1947 Lowe's discovered that this clay could be used as a cat box filler and developed their *Kitty Litter*. Variations in the clay composition and in the amounts and types of deodorizers added to the clay have produced other label brands for Lowe's as well as a number of private label brands.

Lowe's bought this property in 1958. They also have two operations in Missouri and one in Tennessee.

Paleocene Porters Creek Clay is trucked from the working pit to the storage shed from which it passes through crushers and screens to reduce the size of the material from large lumps down to granules. Raw clay from the pit contains 38- to 40-percent moisture, but by passing the broken clay through the 100-foot rotary kiln dryers, the moisture content is reduced to 4 to 6 percent. The clay may be heated up to 1100° F. depending on its intended use. The absorption capacity of the clay is greatly increased when heated and hardened. This also prevents it from breaking down into a soft clayey mass when saturated with liquids. The litter is able to absorb its own weight in liquids.


R1E
R2E
15 S
16 S
MAP 2
N
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1
2 mi
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2
3 km
1
2
North Center Sch
Mt. Zion Ch. & Cem
Bethlehem Ch
Pleasant Grove Sch
Levings
Waters Cem
Concord
Olmsted
DAM NO. 53
GRAND
RIVER
OHIO
RIVER
ILLINOIS
KENTUCKY
CINCINNATI
ST. LOUIS
LOUISVILLE
DIVISION
TURNER LOG
Little Turner Lake
Turner Lake
Shelby Lake
Mud Lake Slough
Lake Mud Slough
Beaverdam
Clanton Slough
Oscar
America Sch & Ch
Macedonia Ch
Lowery Cem
America
Hodges
Bayou
Ohio Valley Ch

The dried litter is stored in large bins from which it moves by conveyor belts to the computer-controlled bagging operation that ensures a uniform end product. The litter is sold through national food store chains and supermarkets in addition to many large independent grocers and pet stores. Packaged litter is loaded on unitized barges at this plant and shipped down the Mississippi River to the Gulf where the barges are transshipped to Europe for the company's expanding markets.

Another product manufactured here absorbs oil and grease spills from garage and factory floors. This material is also used as an inert carrier for agricultural chemicals which readily penetrate the heat-treated and hardened clay granules. This promotes a more uniform distribution of the chemicals on a field.

This fuller's earth deposit is one of the Coastal Plain sediments and a part of the Paleocene Porters Creek Formation. This clay generally is very dark gray, but weathering here has lightened it to a light gray or sometimes a tan. The lighter colors are more sought after largely because they are also light in weight.

The following geologic section (fig. 6) was described by P. C. Reed in 1977 from an exposure about 0.6 mile south-southwest from the office area. This section is essentially the same as that exposed in the present operating pit. Any differences noted will be no greater than those noted across the operating pit. This section is located in the SW 1/4 NE 1/4 SE 1/4 Sec. 27, T. 15 S., R. 1 E., 3rd P.M.; Olmsted 7.5-minute Quadrangle.

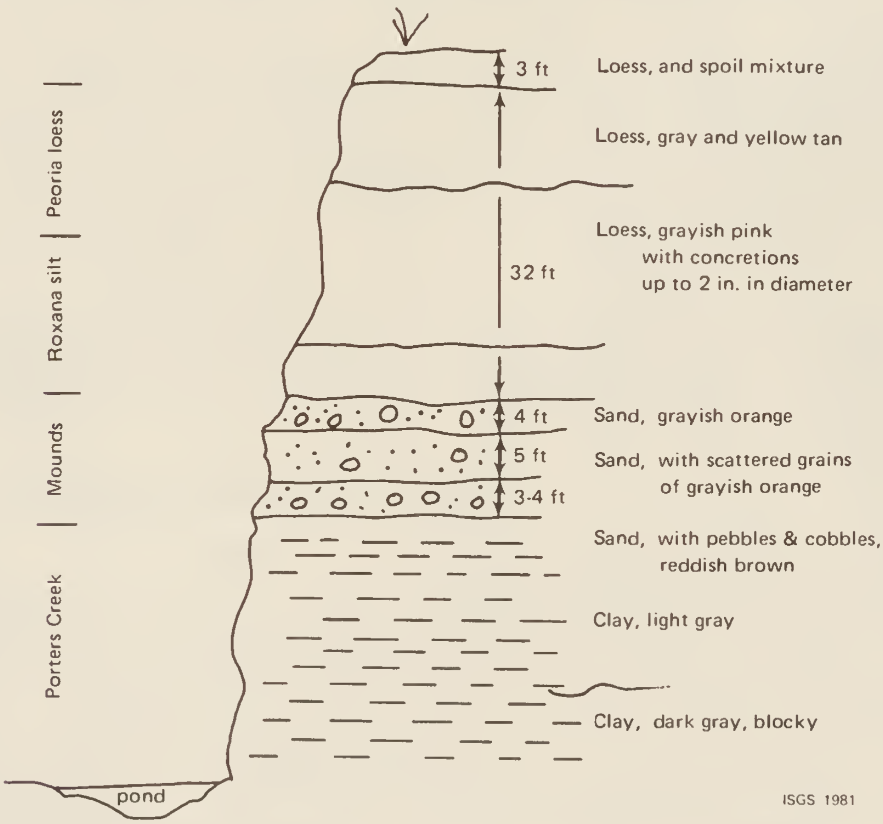


Figure 6. Geologic section. (From Reed, 1977.)

Miles to next point	Miles from starting point	
0.0	18.5	Leave Stop 1. Retrace route to Caledonia Avenue.
0.2	18.7	STOP; 1-way. TURN RIGHT (northeast) on Caledonia Avenue.
0.1	18.8	T-road from right. CONTINUE AHEAD (northeast).
0.55	19.35	Leave Olmsted. CONTINUE AHEAD (northeast) on gravel road.
1.6	20.95	T-road from right. TURN RIGHT (east) on black-top road at sign to U.S. Army Corps of Engineers Lock and Dam No. 53.
0.9	21.85	CAUTION—enter gate to Lock and Dam No. 53.
0.05	21.9	Stop 2.

STOP **2**

Lock and Dam No. 53. SE 1/4 SW 1/4 NW 1/4 Sec. 18, T. 15 S., R. 2 E., 3rd P.M., Pulaski County; Olmsted 7.5-minute Quadrangle.

Park on narrow circular drive and walk south to overlook.

Periods of low water levels prior to 1900 made navigation on the Ohio River impossible. Congress recognized the importance of this waterway to the economic growth of the nation and appropriated funds for the construction of a series of dams to canalize the Ohio River. The 981 miles from Cairo to Pittsburgh, Pennsylvania, had 46 lowlift locks and dams to improve navigation year round.

Originally, single locks, 600 feet long by 110 feet wide, were sufficient to handle the river traffic. After World War II large diesel-powered tugboats became commonplace on the river and the tows they were capable of moving were too large for the older locks. This necessitated breaking the tows and double-locking them in order to proceed. This was quite time consuming and caused many delays in moving materials, as well as creating frequent traffic jams near the dams and locks.

In the early 1950s, Congress authorized the Corps of Engineers to begin replacing the older lock facilities. Depending on traffic conditions, each of the 19 new dam structures was to have at least one 1,200-foot lock and one 600-foot lock. The modernization proceeded downstream from Pittsburgh; the result was that the lower part of the river, which had carried the heaviest traffic, was worse off than before.

To alleviate the immediate problem, temporary 1,200-foot locks were proposed and constructed. Construction time on these temporary locks was shortened and costs were less.

This dam is a wicket type with a length of 3,766 feet and a navigable pass of 932 feet across the dam during periods of high water levels when the locks are not needed. Normal lower pool elevation is 276 feet (m.s.l.); upper pool elevation is 290 feet (m.s.l.).

The shoreline of the river here is covered with Mounds Gravel. It was reported to have been struck in the river bed when construction of the 1,200-foot lock was under way. Construction people called large pieces of the gravel that were cemented together to form conglomerate, "peanut-brittle rock."

Several exposures of gray to ochre silty clay of the Cretaceous McNary Formation occur 700 to 1,000 feet downstream from the dam control building.

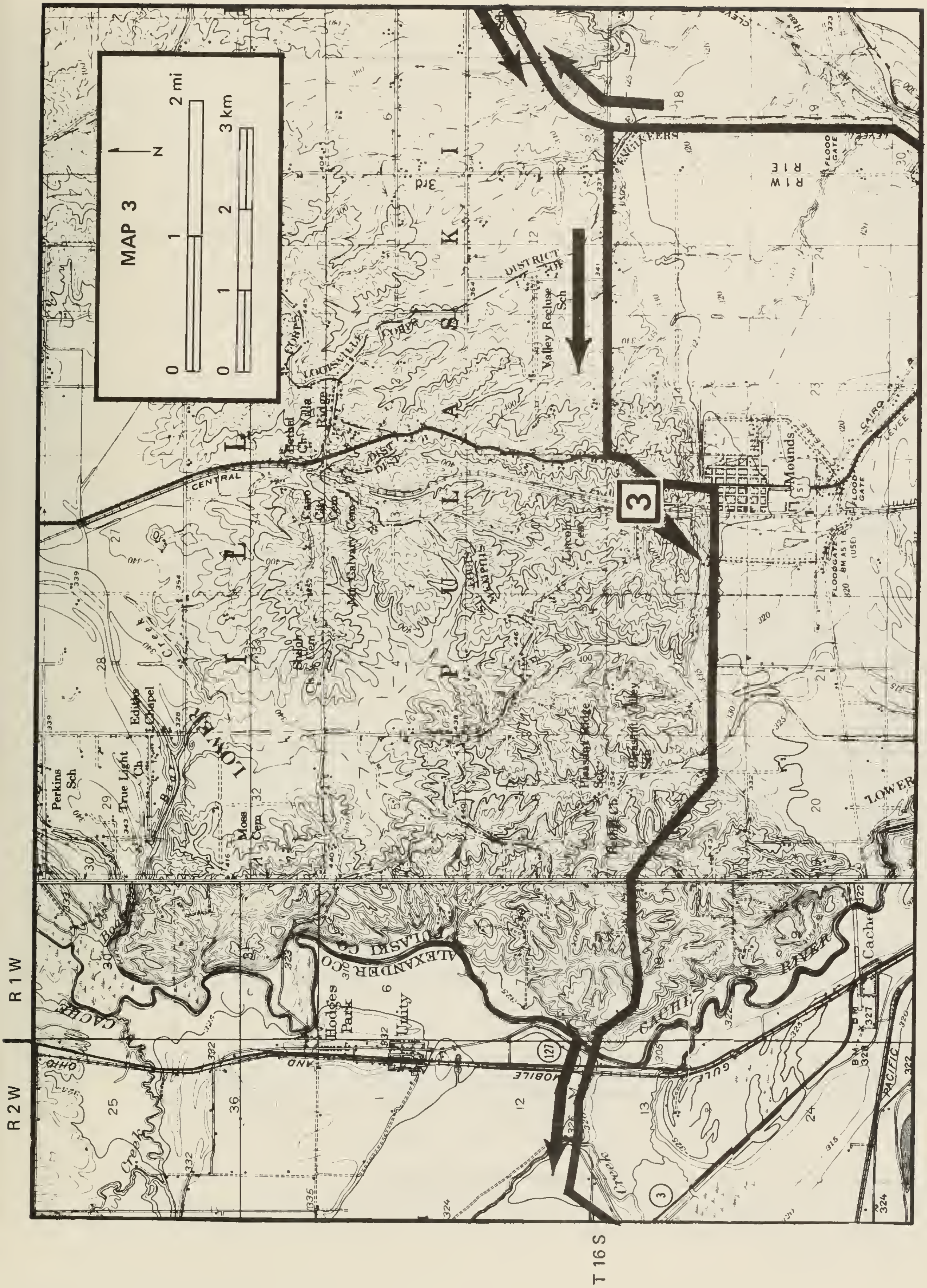
Miles to next point	Miles from starting point	
0.0	21.9	Leave Stop 2. Continue around circle drive to main entrance.
0.15	22.05	Leave Lock and Dam No. 53 property.
0.9	22.95	STOP; 1-way. TURN RIGHT (north) on gravel road.
0.45	23.4	T-road from right. CONTINUE AHEAD AND LEFT (northwest).
0.35	23.75	STOP; 2-way. TURN LEFT (southwest) on Ill. 37.
2.3	26.05	CAUTION: Olmsted Road. CONTINUE AHEAD (southwest).
5.6	31.65	CAUTION; prepare to turn right.
0.1	31.75	TURN RIGHT (west) on Mounds Road.
0.3	32.05	The approaching crossroad is the Third Principal Meridian discussed at the beginning of the field trip.
1.15	33.2	CAUTION; I-57 interchange.
0.1	33.3	Cross over I-57.
0.85	34.15	STOP; 1-way. TURN LEFT (southerly) on U.S. 51 toward Mounds.
0.45	34.6	CAUTION: enter Mounds. Prepare to turn right at base of hill.
0.3	34.9	TURN RIGHT (west) on Sycamore Street.
0.2	35.1	CAUTION; ICG RR crossing; 3 tracks. Rough crossing.
0.35	35.45	STOP 3. Discussion of Cenozoic deposits exposed in Sam Moses' pit behind his home.

STOP 3

Sam Moses' Pit. S 1/2 NW 1/4 SW 1/4 Sec. 15, T. 16 S., R. 1 W., 3rd P.M., Pulaski County; Cairo 7.5-minute Quadrangle.

CAUTION—FAST TRAFFIC—Park off the road as far as safety permits. Exit and enter car from passenger side ONLY! Walk north about 400 feet into the pit.

The composite stratigraphic section of Sam Moses' pit is from Kolata (1981).


MAP 3
N
0 1 2 mi
0 1 2 3 km
Mounds
Hodges Park
Unity
Valley Recluse Sch
Lincoln Cem
Mt Calvary Cem
Perkins Sch
True Light Ch
Moss Cem
Cache
PULASKI CO
ALEXANDER CO
CACHE RIVER
CENTRAL
MOBILE
OHIO
PACIFIC
CAIRO LEVEE
DISTRICT
R 1 W
R 2 W
R 1 E
T 16 S

The upper part of the stratigraphic section, including the top few feet of the Wilcox Formation, consists of outcrop descriptions from the pit. The lower part of the section consists of descriptions of split spoon samples taken every 10 feet from two test holes drilled in the floor of the pit.

	Thickness (feet)
Quaternary System	
Pleistocene Series	
Wisconsinan Stage	
Woodfordian Substage	
Peoria Loess	
Silt, massive; Modern Soil at top; light brown to light brownish gray with depth; nodular calcareous concretions in lower part.	12
Altonian Substage	
Roxana Silt	
Silt, massive; Farmdale Soil in top; light brownish to grayish red; clayey; becomes more brownish red at base, indicating a transition to the underlying silt.	7
Illinoian Stage	
Loveland Silt	
Silt, blocky; Sangamon Soil at top; reddish brown; clayey; dark brown clay skins coat the blocky fractures; scattered chert pebbles increase in abundance toward base, indicating colluvial deposition that incorporates material from the underlying gravel.	6
Tertiary System	
Pliocene-Pleistocene Series	
Mounds Gravel	
Gravel, pebbles are predominantly chert with some sandstone and siltstone, subangular to subrounded, dominantly coated with a glossy, moderate yellow-brown to brown patina, most are 0.75 to 1.5 in. in diameter; a few sandstone boulders occur, the largest one observed was 3 ft in diameter; a few ellipsoidal to ovoidal milky quartz pebbles up to 0.75 in. in diameter are present; matrix is reddish brown to orangish brown silt and clay in various proportions; sand and silt lenses locally up to 4 ft thick near the top of the section, usually clayey, reddish brown, and some cross-bedding; a lens of light-gray clay up to 8 in. thick occurs in about the middle of the pit face over a distance of about 200 ft; iron hydroxides form liesegang-like cemented zones in various places in the gravel and sand lenses; occasionally very low angle and broad cross-bedding can be recognized in the gravel; the contact with the underlying sand is erosional as indicated by the abrupt change of material and the presence of reworked subangular to subrounded cobbles of iron hydroxide-cemented chert pebble conglomerate lying on the sharp contact.	20
Eocene Series	
Wilcox Formation	
Sand, fine- to coarse-grained; clean to moderately silty and clayey, often micaceous; in places the top 6 ft is heavily iron-stained to reddish brown; generally, the sand is white, light gray to yellowish gray or pale yellow-orange; upper contact with Mounds is very irregular with up to 6 ft of relief in pit area; contains some iron concretions 1 to 2 in. in diameter, some are elongated vertically resembling fossil burrows; heavy minerals apparent in places up to ~ 1 percent; generally horizontally bedded; some cross-bedded units average 6 in. thick; occasionally contains up to 10 percent pebbles, consisting of up to 0.5 in. diameter ellipsoidal to ovoidal, milky to pink to reddish brown, translucent quartz pebbles and up to 1 in. in diameter ellipsoidal to variably shaped, subangular, medium to dark gray, polished chert pebbles; grayish-orange (buff) clay balls up to 2 in. in diameter are also present; occasional clay beds range from minute laminae up to 6 ft thick locally within the pit area; they are very light yellowish to pinkish gray with some areas of stronger pinkish coloration.	40
Paleocene Series	
Porters Creek Formation	
Clay, light olive to medium gray, mottled with yellowish orange areas; plastic; non-calcareous.	10
Clay, massive; medium dark to dark gray; possibly bioturbated; firm; non-calcareous; slightly silty and micaceous; occasional sublaminar partings or lenses of silt as close as 0.25 to 0.5 in. apart; lower 40 ft contains scattered glauconite pellets, very thin lenses of very fine sand, and fine sand-sized disc-shaped amber crystals of siderite; clay is darker gray in lower 40 ft and has more abundant sublaminar mottled zones of slightly lighter gray.	90
Clayton Formation	
Clay, very dark greenish gray; slightly silty and micaceous, especially in thin laminations and lighter colored mottled areas; scattered glauconite pellets; moderately calcareous and fossiliferous; becomes sandy, more silty, and micaceous and non-calcareous with depth; clay becomes moderately light olive gray with mottled patches of dusky yellow and some sand beds with depth.	16
Cretaceous System	
Gulfian Series	
Owl Creek Formation	
Clay and sand, alternating beds, dominantly clay; clay is dark gray, silty, sandy, micaceous, beds up to 1 in. thick; sand is clayey to clean, moderate gray to very light gray, micaceous, beds up to 0.5 in. thick; glauconite pellets occur in both clay and sand; non-calcareous.	+14

Strata in Sam Moses' pit have been offset roughly paralleling the pit face at several places. Detailed work by Survey staff members on drill holes placed on both sides of the largest offset shows that there is no displacement of beds below about the middle of the Wilcox Formation. This clearly indicates that the offsets were the result of land slides along the old Ohio River Valley. Perhaps the river at one time undercut this slope and helped to cause the slumping.

Miles to next point	Miles from starting point	
0.0	35.45	Leave Stop 3. CONTINUE AHEAD (west).
3.8	39.25	Cross Cache River.
0.1	39.35	STOP; 4-way. Junction of Illinois Route 3 and 127. CONTINUE AHEAD (westerly) on Ill. 3.
0.05	39.4	CAUTION—ICG RR crossing.
0.7	40.1	Prepare for left turn.
0.1	40.2	TURN LEFT (southerly) at Horseshoe Lake Conservation Area sign.
2.5	42.7	Prepare for right turn.
0.1	42.8	TURN RIGHT (northwest).
0.05	42.85	Horseshoe Lake Conservation Area picnic area and parking lot to left. PARK. STOP 4. LUNCH.

Horseshoe Lake Conservation Area. SE 1/4 SE 1/4 NE 1/4 Sec. 21, T. 16 S., R. 2 W., 3rd P.M., Alexander County; Cache 7.5-minute Quadrangle.

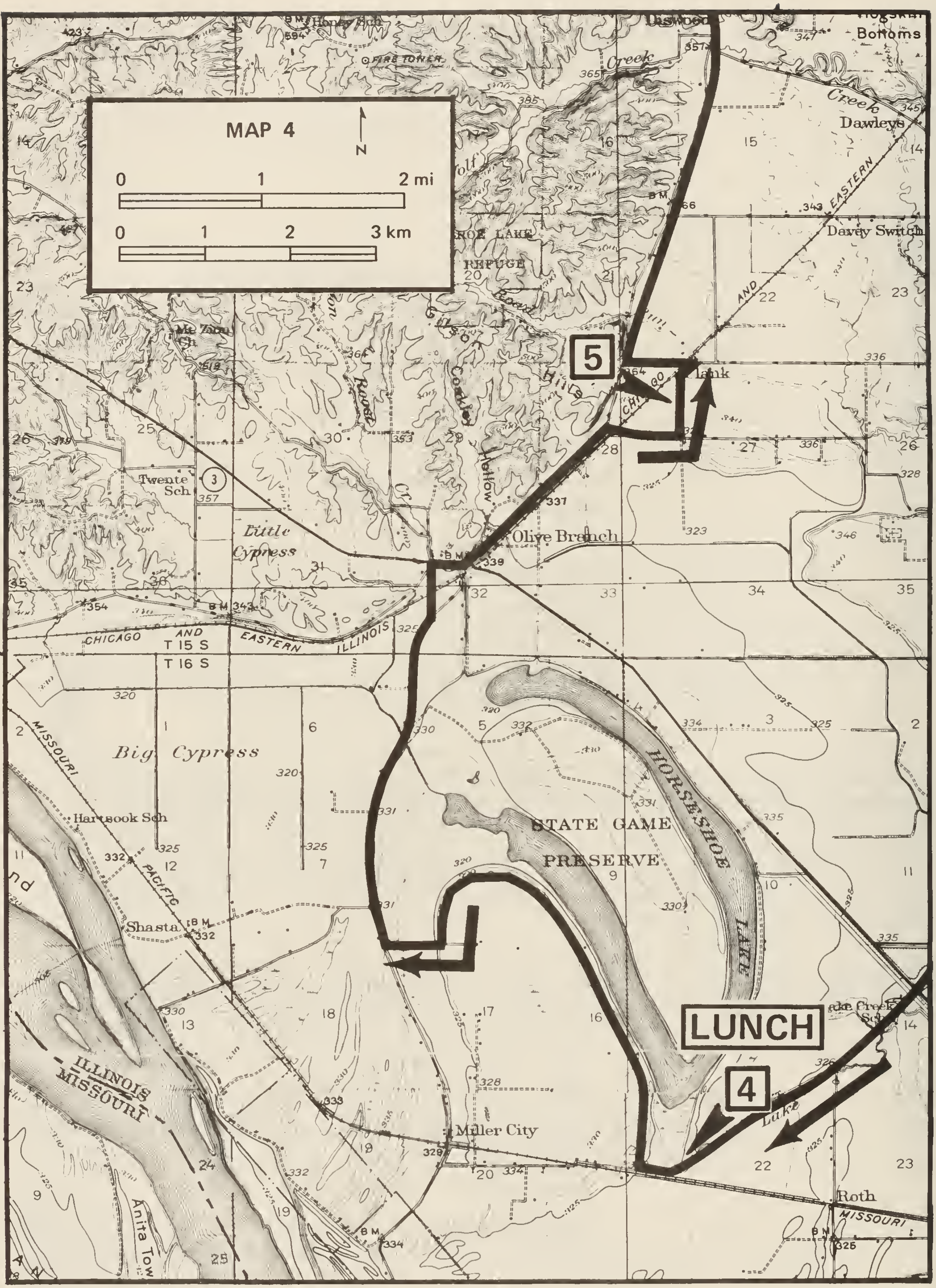
STOP 4

The Horseshoe Lake Conservation Area totals more than 7,900 acres, including a 2,400-acre shallow-water lake that is situated in an abandoned meander loop of the Mississippi River. The Illinois Department of Conservation purchased property here in 1927. In 1939 a concrete spillway was constructed in order to better maintain a more uniform lake level. The lake has a maximum depth of about 6 feet and a shoreline of 20 miles. Shallow-water fishing is good in this lake.

Canada geese began wintering in this vicinity in 1928. Now, more than 150,000 geese winter here. Green pasture and grain crops are produced on the property to sustain the goose population during the wintering period.

0.0	42.85	Leave Stop 4 and return to main blacktop.
0.05	42.9	STOP; 1-way. TURN RIGHT (southwest).
0.15	43.05	Cross Horseshoe Lake concrete spillway bridge.
0.25	43.3	TURN RIGHT (northerly) on Horseshoe Lake Conservation Area camping area road.
3.1	46.4	Conservation Area maintenance facilities to left. CONTINUE AHEAD (south and then west).

R 2 W



T 15 S

T 16 S

Miles to next point	Miles from starting point	
0.45	46.85	STOP; 1-way. TURN RIGHT (northerly) toward Olive Branch and Ill. 3.
1.45	48.3	Cross Black Creek.
1.2	49.5	CAUTION—enter Olive Branch.
0.1	49.6	CAUTION—Missouri Pacific Railroad (MP RR) crossing.
0.05	49.65	STOP; 1-way. Rock ledge to north across highway is the Lower Devonian Bailey Limestone Formation. TURN RIGHT (east) on Ill. 3 and prepare for left turn.
0.05	49.7	CAUTION—TURN LEFT (northeast) before railroad crossing.
0.3	50.0	Leave Olive Branch.
0.35	50.35	Abandoned silica quarry and processing plant to left.
0.3	50.65	Abandoned silica mine to left.
0.3	50.95	Abandoned silica quarry to left.
0.1	51.05	TURN RIGHT (easterly).
0.05	51.1	CAUTION MP RR crossing.
0.45	51.55	TURN LEFT (north) at crossroads.
0.25	51.8	STOP 5

<u>View of Cache Valley and discussion of history of Ohio River and the Cache Valley</u>. W edge SW 1/4 SW 1/4 NW 1/4 NW 1/4 Sec. 27, T. 15 S., R. 2 W., 3rd P.M., Alexander County; Tamms 7.5-minute Quadrangle.

STOP 5

The general pattern of drainage across Illinois and the midwestern states was set millions of years ago (long before the Pleistocene glaciations), when the region became the lowland between the Appalachian and Rocky Mountains. For eons rivers from the north, east, and west have met in the low-lying Illinois region to flow southward to the sea. However, until near the end of the Pleistocene Epoch, only a few thousand years ago, the courses of many of the ancient large rivers in the Midwest did not follow present-day drainage lines. Figure 7a shows some of the river systems that existed before the last glaciation began. Not all of the streams shown existed at the same time.

The Pleistocene glaciations changed ancient drainage lines north of Missouri and Kentucky. One glacier after another diverted and buried river valleys and released immense quantities of meltwater which eroded new channels across the region. The last glaciation led to the creation of the present-day drainage system, shown in figure 7b.

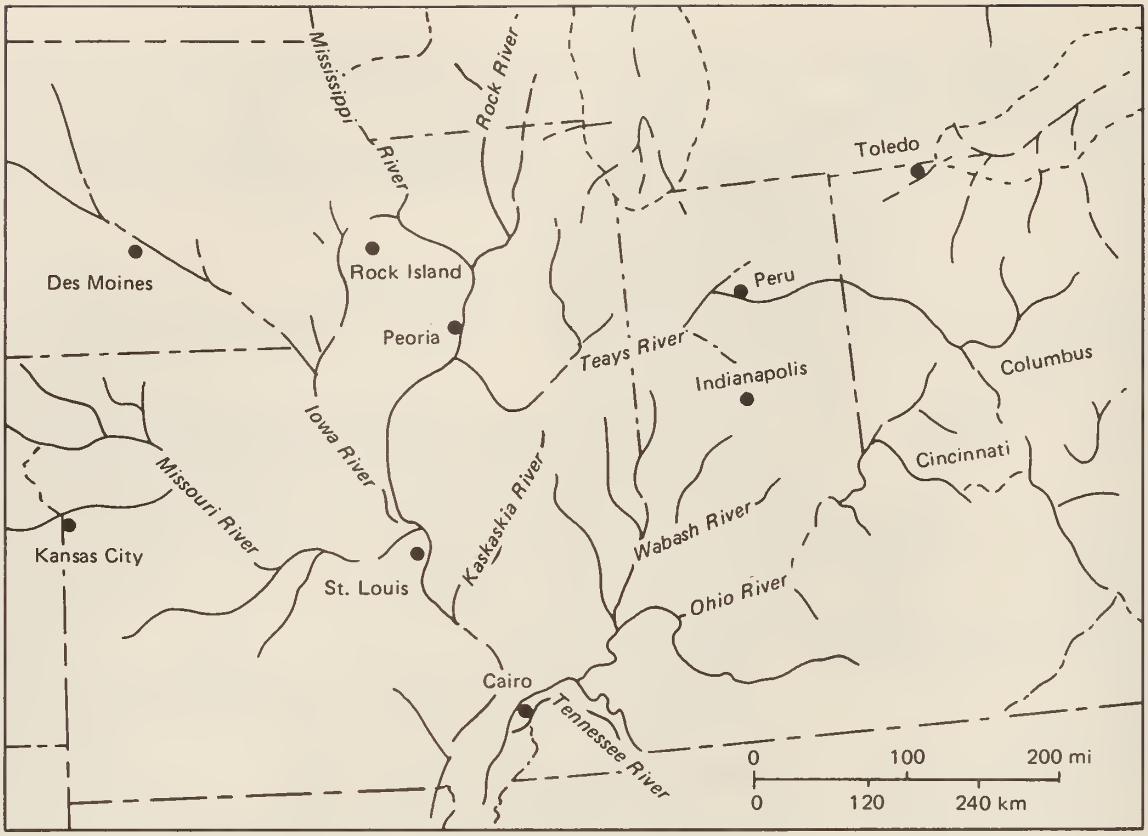


Figure 7a. Drainage systems developed before the last (Wisconsinan) glaciation.

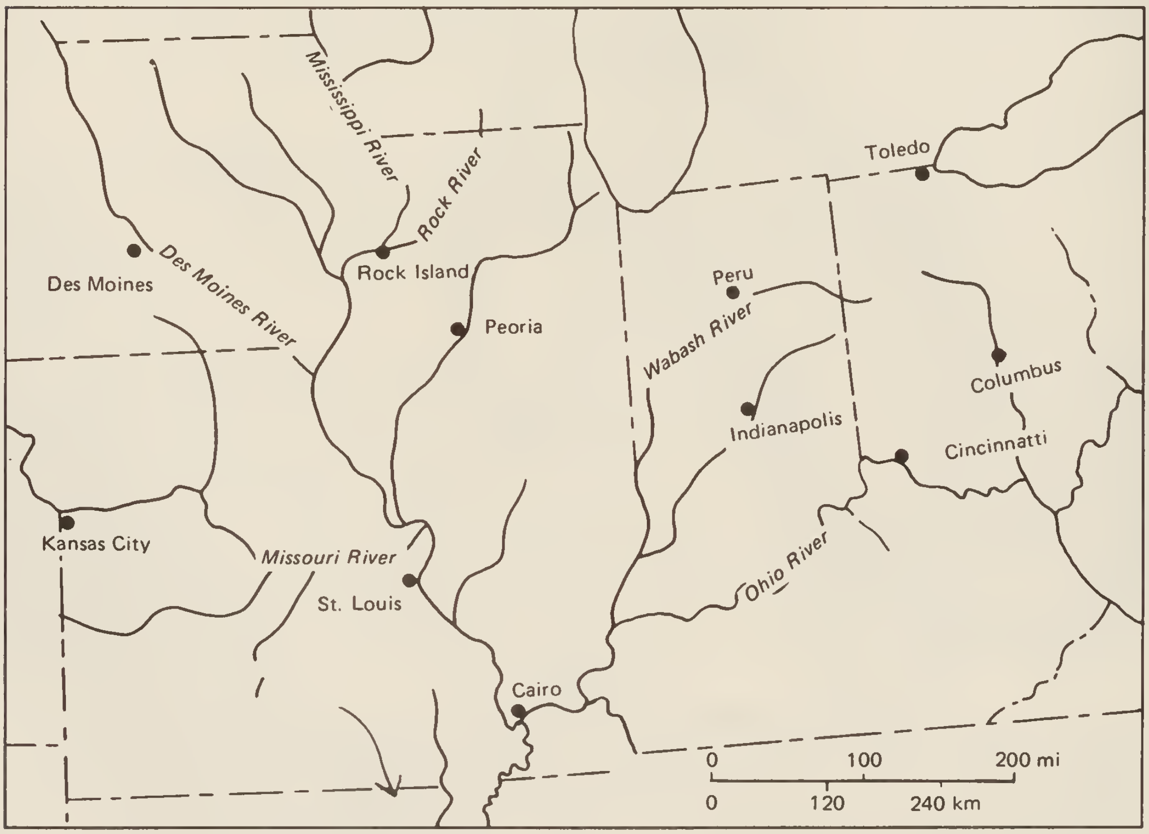


Figure 7b. The present drainage system.

Figure 7a, which shows drainage that no longer exists, is based on a great deal of direct evidence. There are, for example, large valleys like the Cache that are too deep and wide to have been cut by the little streams they now contain and that were, in fact, made by large rivers diverted from them during the glaciations. More evidence comes from studies made of thousands of wells penetrating the thick deposits of mud, sand, and gravel covering the glaciated region. These show that the bedrock surface is not smooth but instead is channeled by valleys buried beneath river and glacier deposits. Furthermore, it can be shown that parts of the modern Ohio, Mississippi, Missouri, and Illinois Rivers skirt the edges of glacial deposits—indicating that the streams developed these parts of their courses along the edges of glaciers. In other places the alignments of river and stream valleys and the deposits in the valleys identify them as channels cut by meltwaters draining from glaciers.

The origin of the Cache Valley has been a problem of interest to many geologists. Most have concluded that the valley served as the channel for the Ancient Ohio River before the river was diverted into the modern Ohio Valley.

Figure 8a shows the present drainage in extreme southern Illinois. The location of the Cache Valley is shown on the figure by the lines representing the Cache River and Bay Creek, which flow through the valley. The Cache is a broad, flat-bottomed valley, ranging in width from 1 1/2 to 4 miles, averaging about 3. The north valley walls are 150 to 250 feet high. Generally the valley follows the contact of the Cretaceous and Mississippian rocks (K and M on the geologic map in the appendix) across southern Illinois as far west as Cairo. Therefore, the north wall of the valley, which is cut in hard Paleozoic rock, is marked by cliffs and steep hills, whereas its south wall, cut through soft, unconsolidated Cretaceous and Tertiary sediments, is marked by gentle slopes.

Bay Creek, in the east end of the Cache Valley, flows eastward into the Ohio River above Bay City. The Cache River flows west into the Ohio just above Cairo. Both streams are small and sluggish—the Cache Valley has very little slope and has been ditched in places. Seasonal floods from the Ohio back up into the Cache Valley and cover the floodplains of the streams. Hundred-year floods cover the slightly higher parts of the valley floor above these floodplains.

Most geologists believe that the Ohio River flowed through the Cache Valley until it was diverted sometime during the Pleistocene Epoch. They observe the cause of the diversion could have been the outwash and meltwater that filled the valley during times of glaciation and could have raised the river until it overtopped a low divide, ran into an adjacent river, and abandoned the Cache Valley. The various lines of evidence and reasoning used to support these conclusions are too complex to be reported in this space, but these general observations are involved in them:

1. The streams now in the Cache Valley and the present-day floods from the Ohio River could not have cut the Cache Valley. The streams are too small, high backwater floods are too infrequent, and both are too sluggish to cut a valley as deep and wide as the Cache.

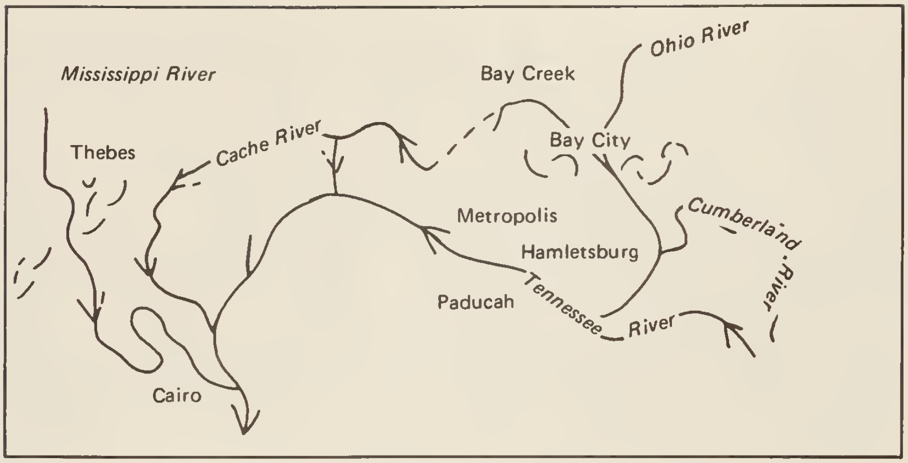


Figure 8a. Present drainage through the Cache, Mississippi, and Ohio valleys in southern Illinois.

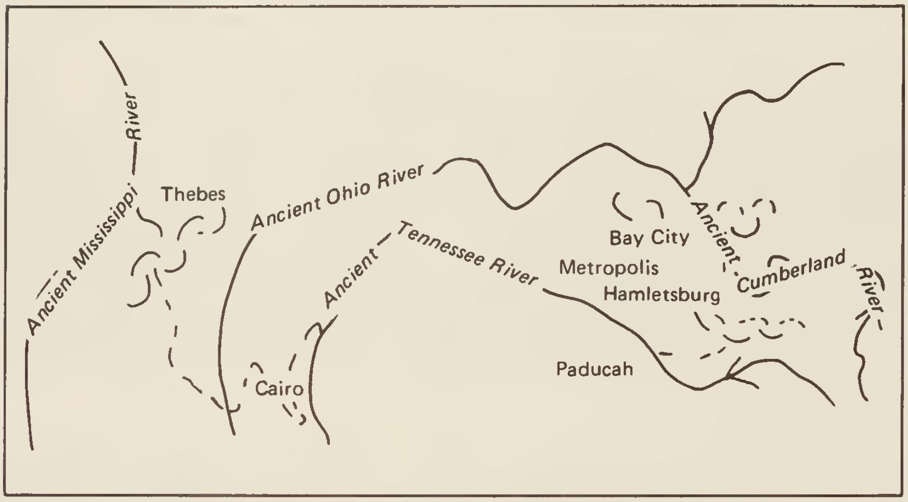


Figure 8b. Lines of drainage proposed to explain a Hamletsburg diversion of the Ancient Ohio River into the present course of the Ohio River.

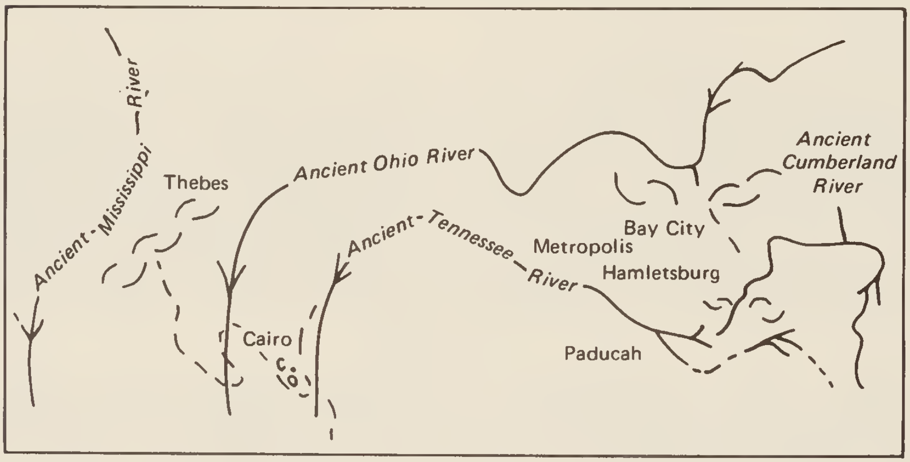


Figure 8c. Lines of drainage proposed to explain a Bay City diversion of the Ancient Ohio River into the present course of the Ohio River.

2. The Cache Valley appears to be an extension of the Ohio Valley. It is connected to and in line with the Kentucky reach of the Ohio River above Bay City (see fig. 8a) and is a more direct course westward than the present Ohio channel.

3. Valleys of the Ancient Cumberland and Ancient Tennessee Rivers and their tributaries could have served as channels for a diversion of the Ancient Ohio from the Cache Valley into the present Ohio Valley to the south.

4. The deep filling of stream-laid clay, silt, and sand beds in the large river valleys indicates enormous volumes of glacial meltwater and outwash that would have been sufficient to fill in the old channels and raise the rivers over low divides into their present courses. The floor of the Cache Valley, for instance, is filled in 140 to 180 feet above the original valley floor cut in bedrock.

There are several theories that explain how the premodern Ohio River drainage in this area looked and how the Ohio came to occupy its present course. Most geologists have argued for a drainage pattern like that shown in figure 8b. They visualize the Ancient Cumberland River flowing northward to join the Ancient Ohio above Bay City at the east end of the Cache Valley. This theory considers the Ohio Valley between Bay City and Hamletsburg to have been the final reach of the Ancient Cumberland River. The Ancient Tennessee River followed its present course westward to Paducah, proceeding from there past Metropolis and Cairo in the valley now occupied by the Ohio River. The Ancient Ohio and Tennessee Rivers join the Ancient Mississippi south of Cairo.

According to this theory the modern drainage shown in figure 8a was established during a time of glaciation when the Ancient Ohio and Ancient Mississippi Valleys were brimming with glacial meltwater and sediments. High water in the Ancient Ohio Valley is thought to have backed up into the Cumberland Valley and spilled over a low divide (shown as) at Hamletsburg into the Ancient Tennessee Valley. The Ohio then abandoned the Cache Valley and followed its present course.

The Mississippi, under the same conditions, established its modern course by overtopping the divide at Thebes and joining the Ohio just south of Cairo. Several workers have suggested that the diversions of the Ancient Mississippi and Ancient Ohio were caused by a particular high water episode called the Kankakee Flood. The Kankakee Flood occurred late in the Pleistocene Epoch, about 14,000 to 15,000 years ago, during the Woodfordian glaciation.

One geologist (Ross, 1964) has suggested that the diversion across the divide at Hamletsburg could have been accomplished by faulting that lowered the divide. The region contains many faults, and some of those near the supposed diversion are parallel to the valley there.

Figure 8c shows the reconstruction of ancient drainage suggested by Leland Horberg (1950). He theorized that only the Ancient Ohio flowed through the Cache Valley. The Cumberland, he believed, joined the Tennessee near Paducah and the Tennessee flowed on in the present Ohio Valley west of Paducah.

According to Horberg's idea, the modern drainage was established in the latter half of the Pleistocene Epoch when glacial outwash filled the lower Ancient Ohio and Mississippi Valleys and meltwater floods overtopped a drainage divide at Bay City, enabling the Ohio to flow southward into the Cumberland near Hamletsburg.

Other suggestions have been advanced to explain the existence of the Cache Valley. H. N. Fisk (Alexander and Prior, 1968) proposed that both the Ancient Tennessee and Cumberland Rivers flowed northwest and joined the Ancient Ohio at the entrance to the Cache Valley. He thought that floods of the Tennessee cut a gap in a divide at Metropolis and fell into a west-flowing tributary of the Ancient Ohio. This diversion, he believed, created the Ohio Valley between Paducah and a point below Cairo.

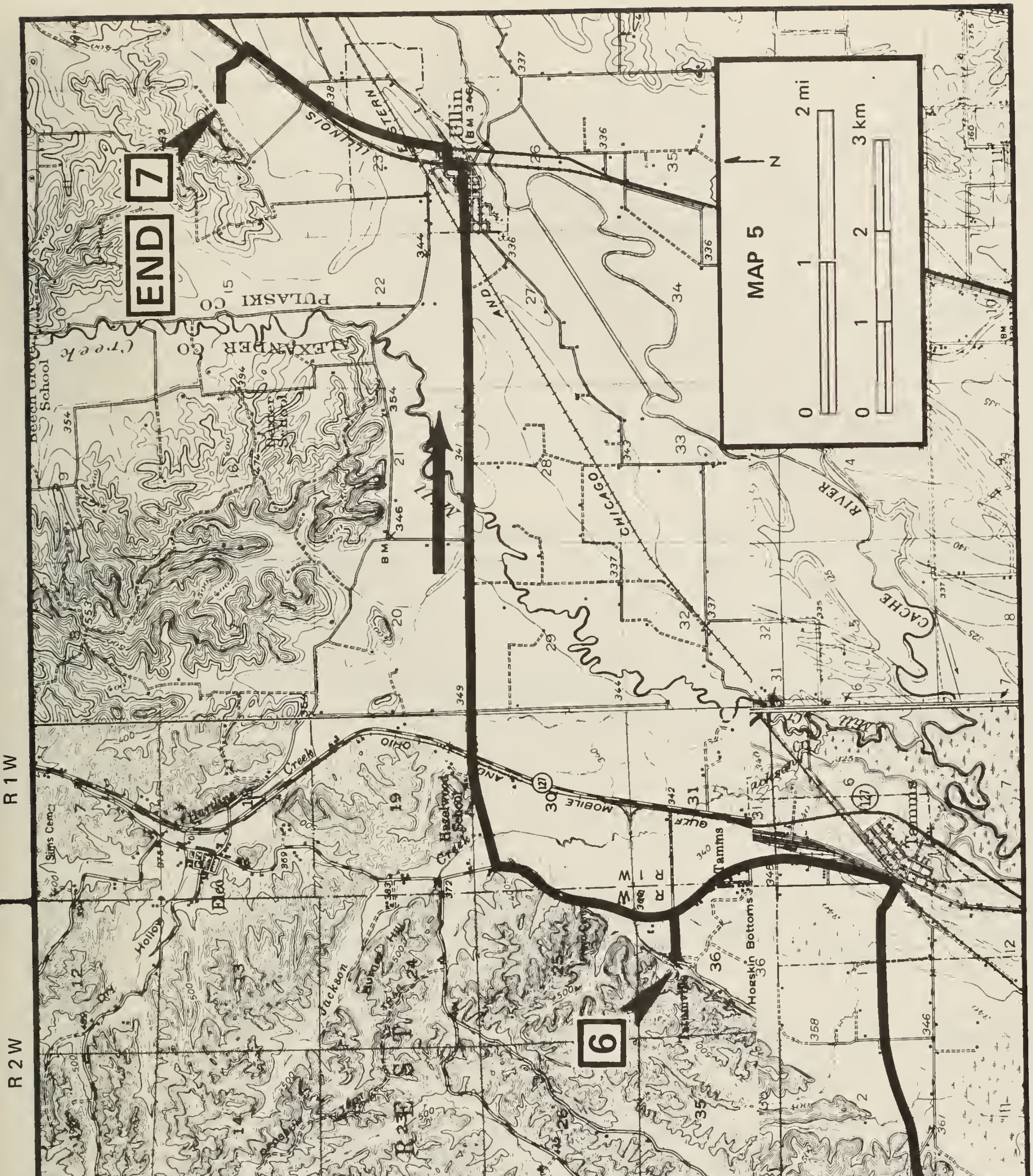
Several workers have suggested that after the Ohio had established its modern course from Bay City to Cairo, it continued to flow for a time through the Cache Valley. Similarly, Alexander and Prior (1968) have visualized the Ohio flowing in both the Cache Valley and its present valley past Metropolis, but argued that the Ancient Ohio did not persistently occupy the Cache Valley. They believe that the Cache Valley was just a spillway for high levels of meltwater from the Ohio near the end of the Wisconsinan glaciation. The ancestral Bay Creek and Cache River, they believe, cut the Cache Valley, which was later eroded by the Ohio's meltwater.

Some of the evidence needed to settle points in dispute is missing or equivocal, and so questions remain to be answered about the origin of the Cache Valley. At present, geologists at the Survey who have worked with the problem support the view represented by figure 8b, the Hamletsburg Diversion.

Miles to next point	Miles from starting point	
0.0	51.8	Leave Stop 5. CONTINUE AHEAD (north).
0.25	52.05	TURN LEFT (west) and immediately cross MP RR.
0.45	52.5	STOP: 1-WAY. TURN RIGHT (northerly).
3.0	55.5	CAUTION—Y-intersection. BEAR RIGHT (easterly).
0.7	56.2	CAUTION—deep roadcut in Lower Devonian Grassy Knob Chert.
		Although each end of the cut shows considerable leaching and attendant slumping, the central part of the cut shows little leaching.
1.95	58.15	CAUTION—enter Tamms.
0.25	58.4	TURN LEFT (northerly) just before MP RR.
1.7	60.1	TURN LEFT (west) at crossroads.
0.25	60.35	STOP 6.

STOP 6

Novaculite gravel deposit of Markgraf Materials Company. Office is near Center N 1/2 Sec. 36, T. 14 S., R. 2 W., 3rd P.M., Alexander County; Mill Creek 7.5-minute Quadrangle.


MAP 5
END 7
6
0 1 2 mi
0 1 2 3 km
N
R 2 W
R 1 W
T 14 S
T 15 S
PULASKI CO
ALEXANDER CO
CACHE RIVER
Tamms
Ullin

CAUTION—some of this material in the quarry face is loose. Therefore, DO NOT stand too close or climb on the face!

The Lower Devonian Grassy Knob Chert Formation is exposed in this quarry. Approximately 185 feet of the formation is exposed in the quarry faces. The Grassy Knob Chert is highly fractured by open joints and contains some conspicuous beds of chert that are more resistant to weathering than most of the exposure. Some thin beds of clay are present. Iron staining is present close below the soil zone at the top and sides of the quarry face and where the face has been long exposed to weathering. A nearby well indicates that the formation may be somewhat more than 315 feet in thickness here. Locally it is difficult to differentiate from formations that lie above and below it. It differs from the underlying Bailey Limestone Formation, noted in the roadcut exposure at Olive Branch, in being lighter colored and in having more solid beds of chert. In this vicinity the Grassy Knob Chert is overlain by the Clear Creek Chert Formation and the contact is extremely difficult to recognize. Fossils are rare in the Grassy Knob Chert.

Lamar (1953) has noted that "the terms 'novaculite' and 'novaculite gravel' have been applied to certain southern Illinois materials for many years. . . . . .novaculite as now commonly used in southern Illinois is applied to dense, white or almost white chert in relatively solid ledges which comprise a deposit several feet or more thick, without other interbedded materials. . . Novaculite gravel is a term loosely applied in southern Illinois to a generally angular chert gravel which usually has not been transported from its place of origin. . ." It seems likely that the terms were applied to some of the materials in southern Illinois because they have a superficial resemblance to certain Arkansas novaculite.

Novaculite gravel has been mined from this locality for many years. A Survey geologist reported in 1927 that material from this quarry had been used for railroad ballast on the Gulf, Mobile and Ohio Railroad (now the ICG RR).

The material quarried here now is used primarily for road construction. The broken material has sharp edges that should be useful as aggregate in top courses of bituminous paving because it would provide resistance to abrasion and scuffing and would thus, provide a skid resistant surface.

Miles to next point	Miles from starting point	
0.0	60.35	Leave Stop 6.
0.25	60.6	TURN LEFT (northerly) at crossroads.
1.1	61.7	Borrow pit to right. Wisconsinan loess overlying silty gravel (Mounds Gravel?).
0.15	61.85	TURN RIGHT (east) at T-road intersection.
0.4	62.25	Abandoned tripoli mine in the Devonian Clear Creek Chert Formation to the left. This mine is featured on the cover of the field trip announcement. CONTINUE AHEAD (east).
0.3	62.55	CAUTION—ICG RR crossing.

Miles to next point	Miles from starting point	
0.05	62.6	STOP; 2-way; intersection with Ill. 127. CONTINUE AHEAD (east).
3.3	65.9	CAUTION—MP RR crossing. Enter Ullin.
0.5	66.4	CAUTION—ICG RR crossing; 4 tracks. TURN LEFT (north) just beyond tracks.
0.1	66.5	TURN RIGHT (east).
0.05	66.55	STOP; 2-way. TURN LEFT (northerly) on U.S. 51.
0.25	66.8	MP RR overpass.
1.05	67.85	Prepare for left turn.
0.1	67.95	CAUTION—TURN LEFT (northwest) at entrance to Columbia Quarry operations and immediately cross ICG RR tracks (2 tracks).
0.35	68.3	STOP 7.

STOP **7**

Columbia Quarry Office. SW 1/4 SE 1/4 SE 1/4 NE 1/4 Sec. 14, T. 14 S., R. 1 W., 3rd P.M., Pulaski County; Dongola 7.5-minute Quadrangle.

Type sections follow of Ullin Limestone; Columbia Quarry Section measured along road into pit and in westernmost part of quarry, April 15, 1966, located SW 1/4 NE 1/4 Sec. 14, T. 14 S., R. 1 W., Pulaski County, Illinois (Dongola 15-minute Quadrangle). (From Lineback, 1966.) Section covered by thick soil.

	Thickness (feet)
SALEM LIMESTONE	
Limestone, bryozoan-crinoid calcarenite, coarse-grained, oolitic, medium brownish gray; irregular wavy beds 6 to 12 inches; poorly developed cross-beds; some chert; contact with Ullin below is very slightly irregular, but lithologies above and below are very similar	10.0
ULLIN LIMESTONE	
Harrodsburg Member	
Limestone, bryozoan-crinoid calcarenite with bryozoan matrix, light brownish gray; coarse-grained at top; small-scale cross-bedding	10.0
Chert and limestone, light gray chert in beds 1 to 3 inches thick in light brownish gray calcarenite limestone	1.0
Limestone, calcarenite, coarse-grained, light gray; poorly defined beds 1 to 3 feet thick; large-scale cross-beds more inclined than in lower part; section inaccessible in quarry face	41.0
Limestone, calcarenite, coarse-grained, light gray; one bed, with steeply dipping cross-beds	2.0
Limestone, calcarenite to calcirudite, coarse-grained, light gray; bryozoan matrix with coarser crinoid fragments than lower units; beds thicker (1 to 2 feet) than lower units	11.0

Limestone, calcarenite to calcirudite, coarse-grained, light gray; matrix of light gray ramose and frondescent bryozoans with fragments of darker colored crinoids; fragments well oriented; some chert; some brachiopods and other fossils; stylolites; beds 6 to 24 inches thick, large-scale low-angle cross-bedding poorly developed	33.0
Limestone, bryozoan-crinoid calcarenite, light gray to light brownish gray, massive; poorly developed beds 6 to 18 inches thick and low-angle large-scale cross-bedding	28.5
Limestone, bryozoan-crinoid calcarenite, medium gray; beds 12 to 18 inches thick; large-scale low-angle planar cross-bedding with some smaller scale cross-bedding superimposed; some chert	10.0
Total Harrodsburg Member	136.5
Ramp Creek Member	
Limestone, bryozoan-crinoid calcarenite, fine-grained, medium dark gray to dark gray; beds 6 to 12 inches; chert in dark gray bands 6 inches apart	15.0
Measured Ullin Limestone	151.5

Section begins at lowest point in quarry floor.

During the early 1880s, a quarry was opened at this locality and three kilns were constructed to produce lime. Limestone ($CaCO_3$) was "burned" with a log fire to release carbon dioxide (CO_2) and produce lime (CaO). There was a large demand for lime for use in masonry construction.

Our cover illustration is of the first kiln constructed here and stands near the south part of the working quarry. The present quarry superintendent, Mr. Bernie Brust, said that a relative of his who was a stone mason handbuilt this particular kiln. The other two kilns at this location were not completely handbuilt and, as a result, did not last very long. This kiln has furnace openings for firing the kiln on the east and west sides and an opening on the south side from which the lime was removed.

The quarry has been operated intermittently throughout its life. Before Columbia Quarry Company bought the property in 1949, it had last been used as a source of railroad ballast early in this century. Agstone and aggregates for road construction are produced here.

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PHYSIOGRAPHIC DIVISIONS OF ILLINOIS

Reprinted 1978

MISSISSIPPIAN DEPOSITION

(The following quotation is from Report of Investigations 216: Classification of Genevievian and Chesterian...Rocks of Illinois [1965] by D. H. Swann, pp. 11-16. One figure and short sections of the text are omitted.)

During the Mississippian Period, the Illinois Basin was a slowly subsiding region with a vague north-south structural axis. It was flanked by structurally neutral regions to the east and west, corresponding to the present Cincinnati and Ozark Arches. These neighboring elements contributed insignificant amounts of sediment to the basin. Instead, the basin was filled by locally precipitated carbonate and by mud and sand eroded from highland areas far to the northeast in the eastern part of the Canadian Shield and perhaps the northeastward extension of the Appalachians. This sediment was brought to the Illinois region by a major river system, which it will be convenient to call the Michigan River (fig. 4) because it crossed the present state of Michigan from north to south or northeast to southwest....

The Michigan River delivered much sediment to the Illinois region during early Mississippian time. However, an advance of the sea midway in the Mississippian Period prevented sand and mud from reaching the area during deposition of the St. Louis Limestone. Genevievian time began with the lowering of sea level and the alternating deposition of shallow-water carbonate and clastic units in a pattern that persisted throughout the rest of the Mississippian. About a fourth of the fill of the basin during the late Mississippian was carbonate, another fourth was sand, and the remainder was mud carried down by the Michigan River.

Thickness, facies, and crossbedding...indicate the existence of a regional slope to the southwest, perpendicular to the prevailing north 65° west trend of the shorelines. The Illinois Basin, although developing structurally during this time, was not an embayment of the interior sea. Indeed, the mouth of the Michigan River generally extended out into the sea as a bird-foot delta, and the shoreline across the basin area may have been convex more often than concave.

....The shoreline was not static. Its position oscillated through a range of perhaps 600 to 1000 or more miles. At times it was so far south that land conditions existed throughout the present area of the Illinois Basin. At other times it was so far north that there is no suggestion of near-shore environment in the sediments still preserved. This migration of the shoreline and of the accompanying sedimentation belts determined the composition and position of Genevievian and Chesterian rock bodies.

Lateral shifts in the course of the Michigan River also influenced the placement of the rock bodies. At times the river brought its load of sediment to the eastern edge of the basin, at times to the center, and at times to the western edge. This lateral shifting occurred within a range of about 200 miles. The Cincinnati and Ozark areas did not themselves provide sediments, but, rather, the Michigan River tended to avoid those relatively positive areas in favor of the down-warped basin axis.

Sedimentation belts during this time were not symmetrical with respect to the mouth of the Michigan River. They were distorted by the position of the river relative to the Ozark and Cincinnati shoal areas, but of greater importance was sea current or drift to the northwest. This carried off most of the mud contributed by the river, narrowing the shale belt east of the river mouth and broadening it west

of the mouth. Facies and isopach maps of individual units show several times as much shale west of the locus of sand deposition as east of it. The facies maps of the entire Chesterian...show maximum sandstone deposition in a northeast-southwest belt that bisects the basin. The total thickness of limestone is greatest along the southern border of the basin and is relatively constant along that entire border. The proportion of limestone, however, is much higher at the eastern end than along the rest of the southern border, because little mud was carried southeastward against the prevailing sea current. Instead, the mud was carried to the northwest and the highest proportion of shale is found in the northwestern part of the basin.

Genevievian and Chesterian seas generally extended from the Illinois Basin eastward across the Cincinnati Shoal area and the Appalachian Basin. Little terrigeneous sediment reached the Cincinnati Shoal area from either the west or the east, and the section consists of thin limestone units representing all or most of the major cycles. The proportion of inorganically precipitated limestone is relatively high and the waters over the shoal area were commonly hypersaline... Erosion of the shoal area at times is indicated by the presence of conodonts eroded from the St. Louis Limestone and redeposited in the lower part of the Gasper Limestone at the southeast corner of the Illinois Basin...

The shoal area included regions somewhat east of the present Cincinnati axis and extended from Ohio, and probably southeastern Indiana, through central and east-central Kentucky and Tennessee into Alabama....

Toward the west, the seaway was commonly continuous between the Illinois Basin and central Iowa, although only the record of Genevievian and earliest Chesterian is still preserved. The seas generally extended from the Illinois and Black Warrior regions into the Arkansas Valley region, and the presence of Chesterian outliers high in the Ozarks indicates that at times the Ozark area was covered. Although the sea was continuous into the Ouachita region, detailed correlation of the Illinois sediments with the geosynclinal deposits of this area is difficult.

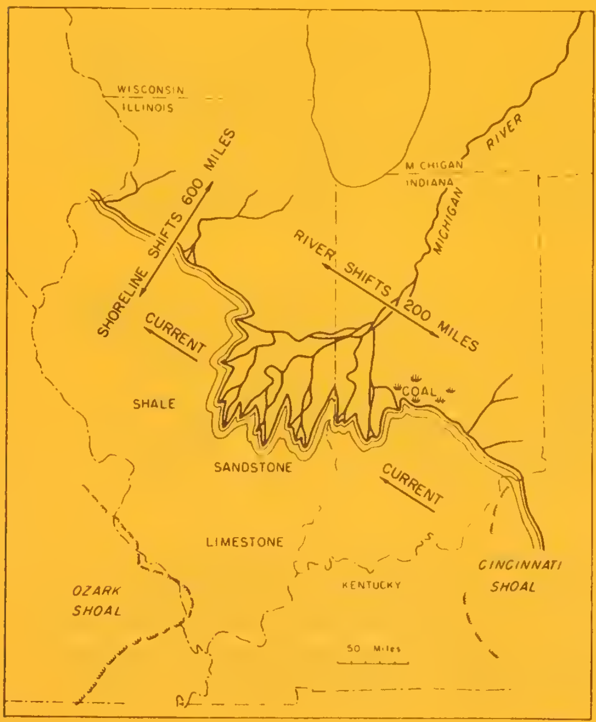


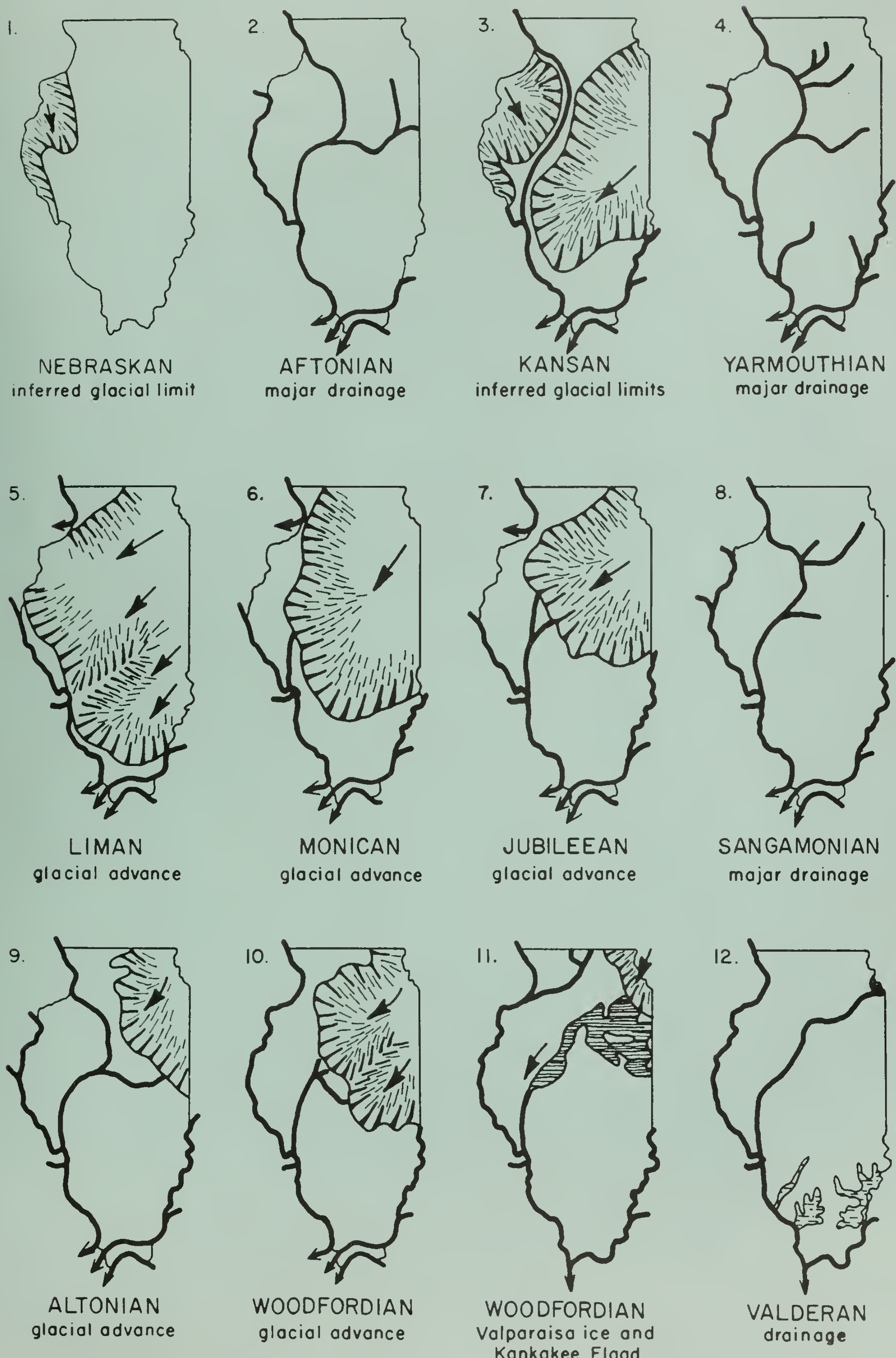
Figure 4: Paleogeography at an intermediate stage during Chesterian sedimentation.

TIME TABLE OF PLEISTOCENE GLACIATION

STAGE	SUBSTAGE	NATURE OF DEPOSITS	SPECIAL FEATURES
HOLOCENE	Years Before Present	Soil, youthful profile of weathering, lake and river deposits, dunes, peat	
	7,000		
WISCONSINAN (4th glacial)	Valderan	Outwash, lake deposits	Outwash along Mississippi Valley
	11,000		
	Twocreekan	Peat and alluvium	Ice withdrawal, erosion
	12,500		
	Woodfordian	Drift, loess, dunes, lake deposits	Glaciation; building of many moraines as far south as Shelbyville; extensive valley trains, outwash plains, and lakes
	22,000		
	Farmdalian	Soil, silt, and peat	Ice withdrawal, weathering, and erosion
	28,000		
	Altonian	Drift, loess	Glaciation in northern Illinois, valley trains along major rivers
	75,000		
SANGAMONIAN (3rd interglacial)		Soil, mature profile of weathering	
	175,000		
ILLINOIAN (3rd glacial)	Jubileean Monican Liman	Drift, loess Drift, loess Drift, loess	Glaciers from northeast at maximum reached Mississippi River and nearly to southern tip of Illinois
	300,000		
YARMOUTHIAN (2nd interglacial)		Soil, mature profile of weathering	
	600,000		
KANSAN (2nd glacial)		Drift, loess	Glaciers from northeast and northwest covered much of state
	700,000		
AFTONIAN (1st interglacial)		Soil, mature profile of weathering	
	900,000		
NEBRASKAN (1st glacial)		Drift	Glaciers from northwest invaded western Illinois
	1,200,000 or more		

(Illinois State Geological Survey, 1973)

SEQUENCE OF GLACIATIONS AND INTERGLACIAL DRAINAGE IN ILLINOIS



(From Willman and Frye, "Pleistocene Stratigraphy of Illinois," ISGS Bull. 94, fig. 5, 1970.)

ILLINOIS STATE GEOLOGICAL SURVEY

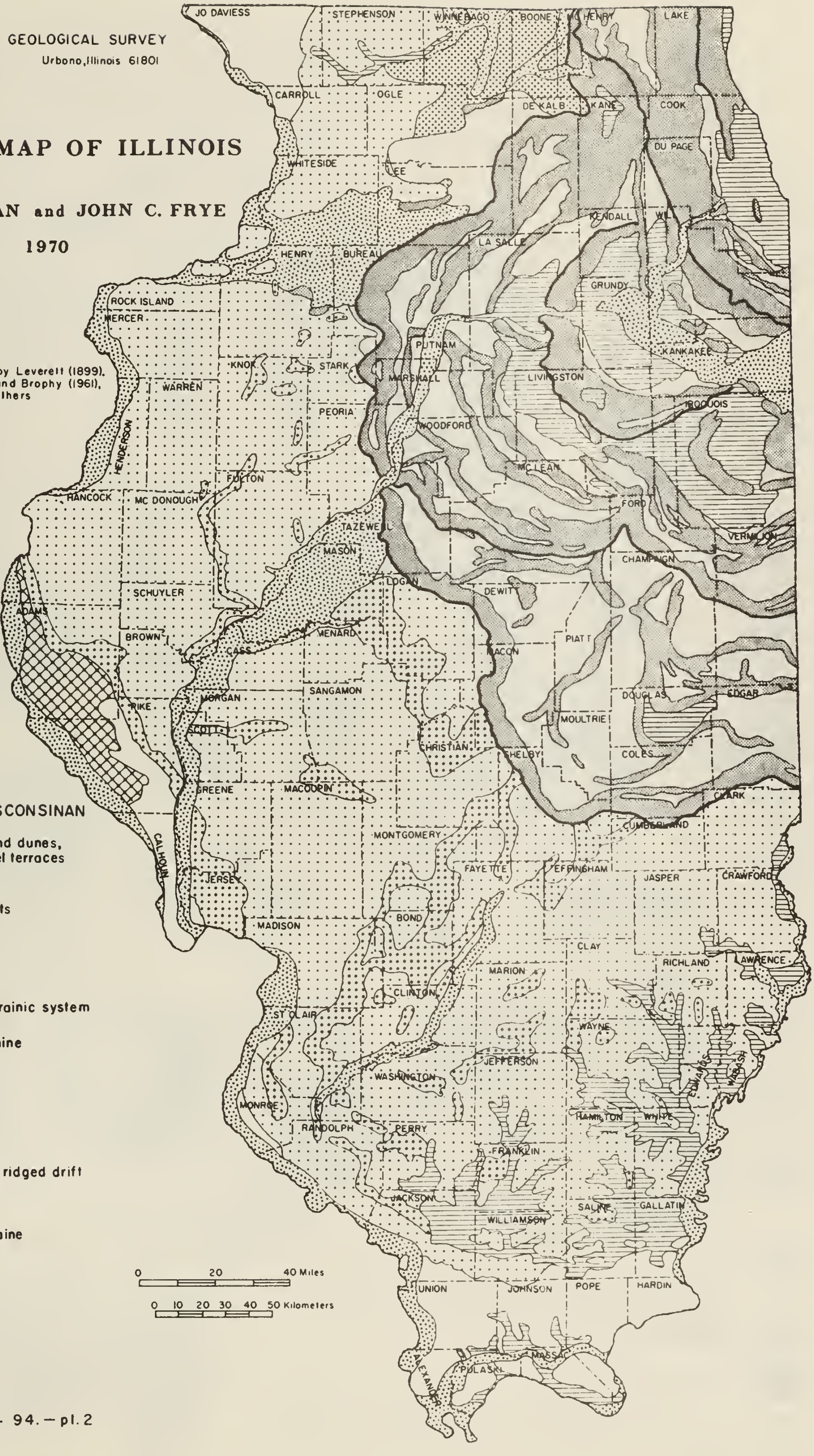
John C. Frye, Chief   Urbana, Illinois 61801

GLACIAL MAP OF ILLINOIS

H.B. WILLMAN and JOHN C. FRYE

1970

Modified from maps by Leverett (1899), Ekblow (1959), Leighton and Brophy (1961), Willman et al. (1967), and others



EXPLANATION

HOLOCENE AND WISCONSINAN

Alluvium, sand dunes, and gravel terraces

WISCONSINAN

Lake deposits

WOODFORDIAN

Moraine

Front of morainic system

Groundmoraine

ALTONIAN

Till plain

ILLINOIAN

Moraine and ridged drift

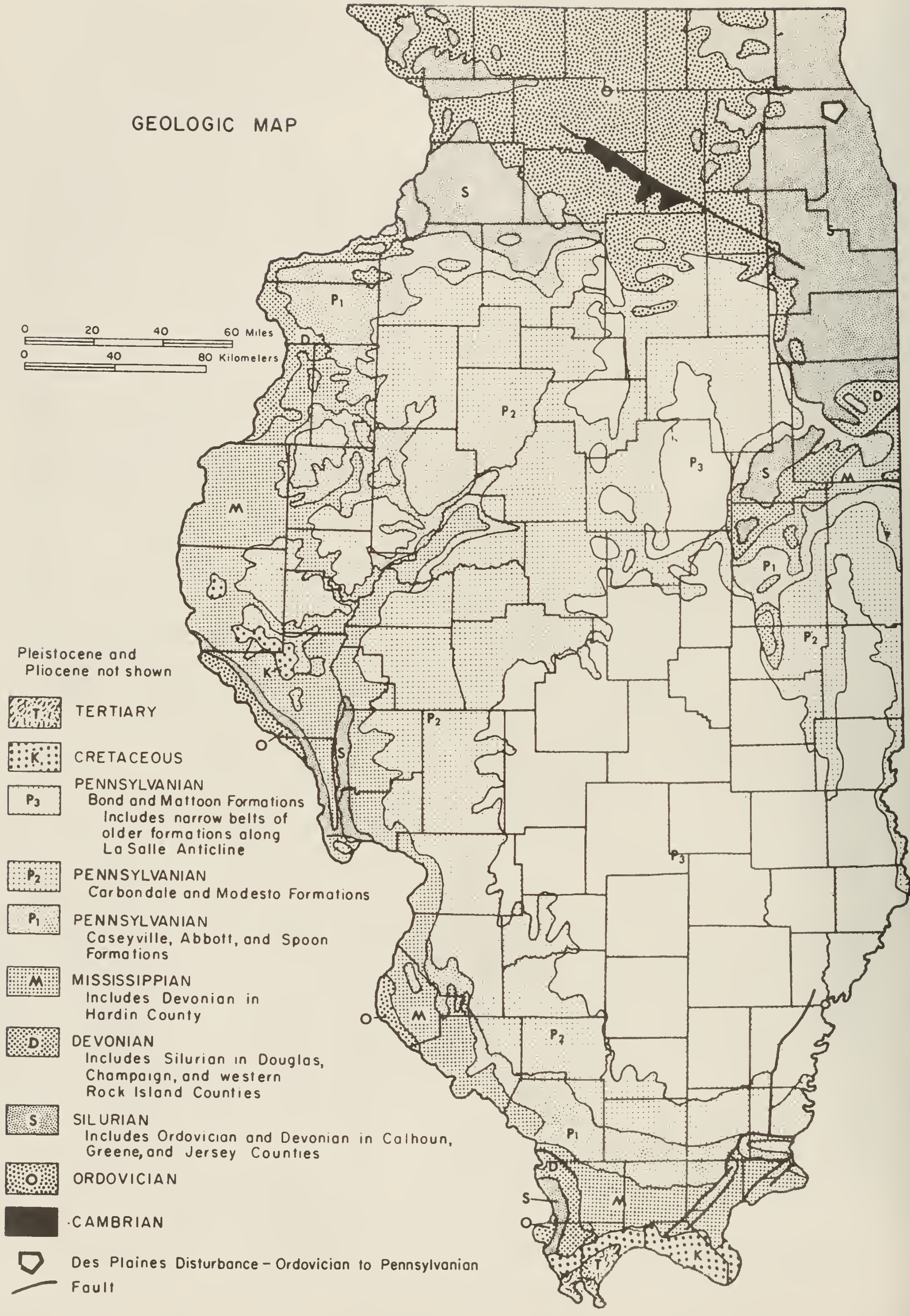
Groundmoraine

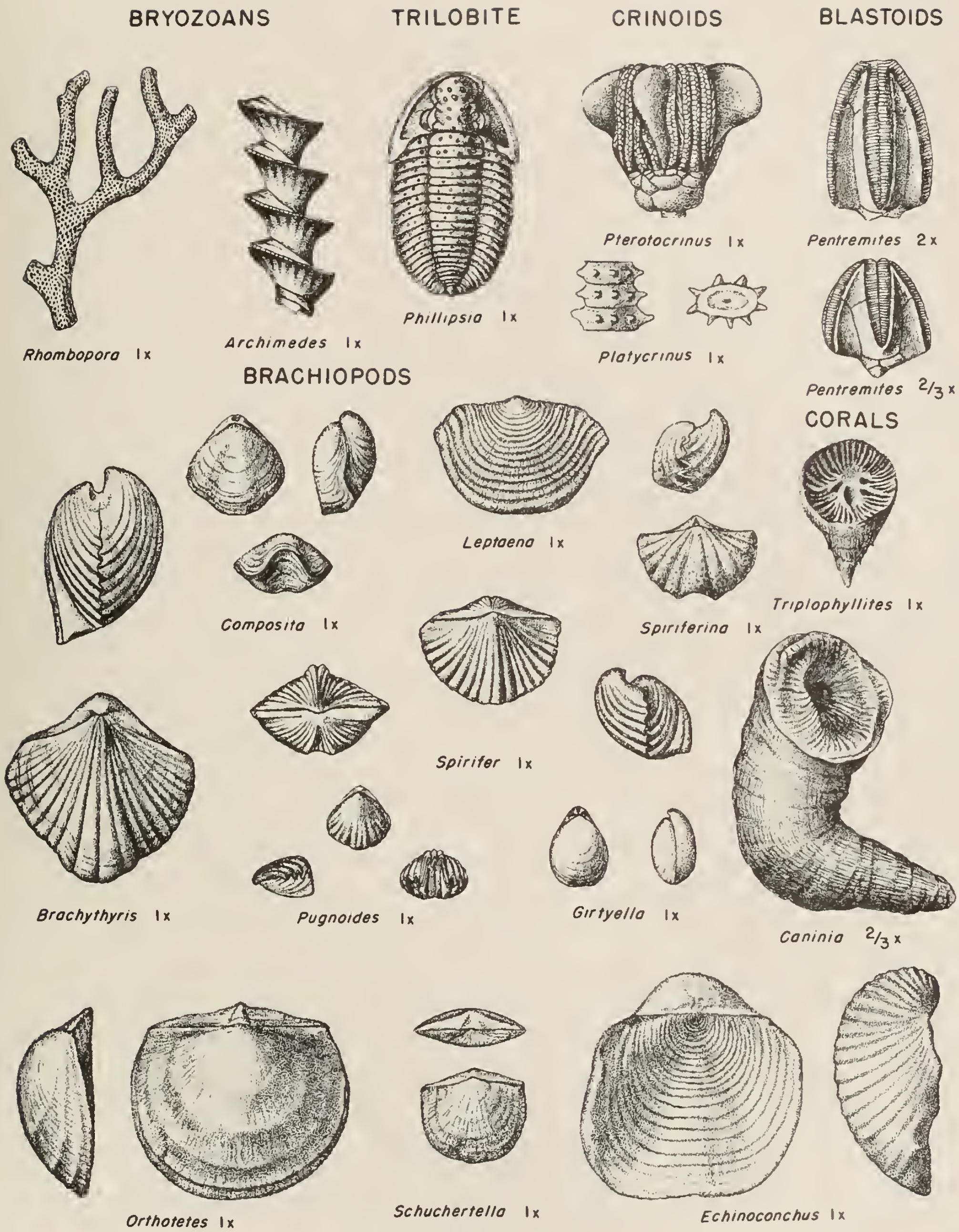
KANSAN

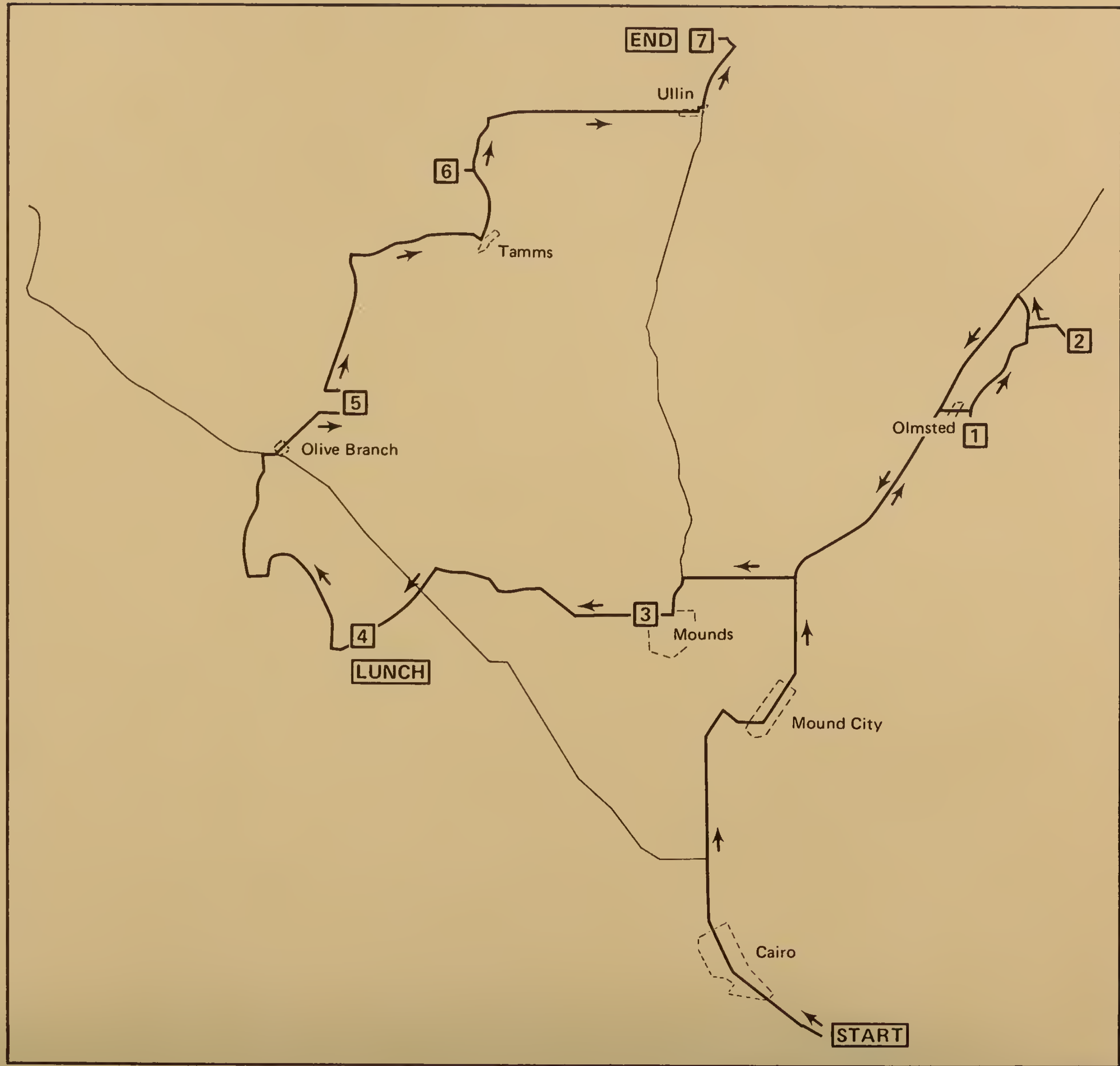
Till plain

DRIFTLESS

Modified from Bull. 94. — pl. 2


GEOLOGIC MAP
0 20 40 60 Miles
0 40 80 Kilometers
Pleistocene and Pliocene not shown
TERTIARY
CRETACEOUS
PENNSYLVANIAN
Bond and Mattoon Formations
Includes narrow belts of older formations along La Salle Anticline
PENNSYLVANIAN
Carbondale and Modesto Formations
PENNSYLVANIAN
Caseyville, Abbott, and Spoon Formations
MISSISSIPPIAN
Includes Devonian in Hardin County
DEVONIAN
Includes Silurian in Douglas, Champaign, and western Rock Island Counties
SILURIAN
Includes Ordovician and Devonian in Calhoun, Greene, and Jersey Counties
ORDOVICIAN
CAMBRIAN
Des Plaines Disturbance - Ordovician to Pennsylvanian
Fault


BRYOZOANS
TRILOBITE
CRINOIDS
BLASTOIDS
Pterotocrinus 1x
Pentremites 2x
Phillipsia 1x
Platycrinus 1x
Rhombopora 1x
Archimedes 1x
Pentremites 2/3x
BRACHIOPODS
CORALS
Leptaena 1x
Composita 1x
Triplophyllites 1x
Spiriferina 1x
Spirifer 1x
Brachythyris 1x
Pugnoides 1x
Girtyella 1x
Caninia 2/3x
Orthotetes 1x
Schuchertella 1x
Echinoconchus 1x



END
7
Ullin
6
Tamms
5
Olive Branch
2
Olmsted
1
4
LUNCH
3
Mounds
Mound City
Cairo
START